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RADIOLOGICAL USE OF HIGH ENERGY DEUTERONS AND ALPHA PARTICLES

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FOR almost twenty years there has been a trend in experimental radiation therapy to develop new methods and instruments that would enable radiologists to irradiate deep lying regions of tissue with the same facility as they irradiate skin. Parallel with that trend, continued efforts were being made to produce radiations which have negligible scattering properties and which serve to irradiate well defined volumes of tissue mass.

When Stone *et al.*[1] built their million volt roentgen-ray generator, the chief aim seemed to be to increase the penetrating power of the roentgen rays, since the low voltage roentgen rays were absorbed exponentially and too rapidly in tissue. The high penetrating power of the roentgen rays obtained solved the problem of transmission, but there was still not enough ionization produced in the deeper tissue relative to the more superficial tissues to produce selective effects. In spite of the increased penetrating ability, the skin dose imposed severe limitations on depth therapy.

Further progress was made a few years later in 1937 when Dessauer *et al.*,[2] du Mesnil de Rochemont[3] and others[4] introduced rotation therapy, in radiological practice. This method consists of rotating the patient around a fixed point in his body, while the roentgen-ray apparatus remains stationary. The tissue immediately around the center of rotation receives the maximum dose, and the dose falls off as the distance from the center of rotation increases. Recently Trump has combined the use of high energy roentgen rays with the rotational method.[12]

With the construction of high energy particle accelerators further progress was made possible. Starting in 1935 biological and medical use of fast neutrons (0–20 mev.) was begun by the Lawrence brothers[5] and these were therapeutically utilized by Stone and his associates.[6] It seemed possible at the time that the high specific ionization of fast neutron recoils might have a differential effect on tumor tissue as compared with normal tissue.

In 1948 the first accounts of the techniques of utilizing high energy roentgen rays from Kerst's betatron appeared.[7] High energy roentgen rays have the advantage of reaching maximum specific ioniza-

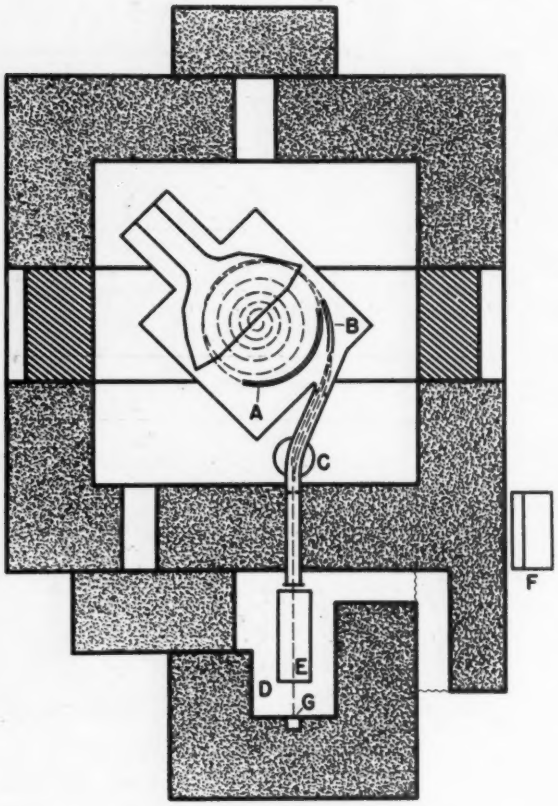

FIG. 1. Schematic layout of the Berkeley 184 inch cyclotron with the deflector system and shielding. The particles start from the ion source in the center of the square vacuum chamber and proceed in a spiral path to larger and larger radii at higher and higher velocities. The ions are produced in pulses of two to ten microsecond duration at the center of the cyclotron vacuum chamber and proceed outward in bunches keeping in step with the frequency modulated oscillations of the Dee. When the required radius of 81 inches is reached, the electrostatic deflector A is turned on momentarily deflecting the particles away from it. The particles then go through a region of higher magnetic field near the center of the magnet and rebound to a deflector B which is essentially a space with reduced magnetic field intensity. The path of the ions then straightens so that they are able to leave the cyclotron chamber and enter an evacuated focusing tube. They pass through some apertures, arriving at an external magnetic focusing device C. A group of protons, deuterons or alpha particles of homogeneous energy is selected and is directed through the focusing tube. The particles proceed out into air through a thin aluminum window in the exposure room D. A special irradiation bench was built for exposing small animals, E. Doses are measured and the beam is controlled from externally located control board, F. While the cyclotron is turned on no one is admitted in chamber D. Outside the concrete shielding, which completely surrounds the cyclotron, the dose is sufficiently low to permit the operators to work all day.

tion at a depth of a few centimeters from the surface of the body; the ionization then decreases exponentially. The roentgen-ray beam is now being used in medical therapy[8] and for biological investigations.[9]

Meanwhile, the 20 mev. electron beam was brought outside of the betatron. The depth tissue dose characteristics[10] of the high energy electrons seem to be better for some purposes than those of high energy roentgen rays because the exit dose is much smaller and the dose rates easily attainable are higher than with roentgen rays. In Germany a group of workers[11] is already using 6 mev. electrons for therapeutic purposes.

By combining rotation or multiple port techniques with the use of high energy roentgen rays or electrons from betatrons, one is able to produce depth doses which are considerably higher than the skin dose.

When radioactive isotopes with high selective uptake are used for internal irradiation of tissues, as in the case of thyroid cancer, it has been determined that the dose delivered to tumor cells should be at least twenty times the dose delivered to surrounding tissues.[13] The external radiations discussed can very seldom achieve this. Furthermore, it is well known to radiologists that in certain cases of radiation treatment, it would be desirable to have the ionization fall off abruptly in a direction lateral to the beam, as well as in the direction of the beam (low exit dose). The latter is desirable, for example, in cancer of the neck region where conventional external radiation treatment often leads to a severe reaction of nearby sensitive tissues (the pharynx, etc.).

In 1946 Wilson[14] suggested the use of high energy proton beams for radiological purposes, proposing that the sharp increase

in ionization near the end point of high energy proton tracks be utilized for the purposes of depth dose therapy.

Two years later, when the Berkeley 184 inch cyclotron was completed by E. O. Lawrence and his associates[15] and after the internal particle beam was successfully deflected and brought out into the air,[16] biological investigations were started by the authors with the high energy nuclei available. The present paper will be chiefly concerned with deuterons (heavy hydrogen ions) and alpha particles (helium ions). We wish to review some of the physical properties of these radiations, their range, dosage determination, biological use, and potential medical applications.

DESCRIPTION OF APPARATUS AND MEASURING TECHNIQUE

The Berkeley 184 inch frequency modulated cyclotron[15] supplies 190 mev. deuterons, 380 mev. alpha particles, and 340 mev. protons. These particles appear in pulses of ten to fifteen microsecond duration ninety times per second. The particles undergo some 10,000 revolutions in the cyclotron along a spiral path until the radius of the path increases to 81 inches. Then a pulsed electrostatic deflector (A, Fig. 1) changes the direction of the particles, bending them toward the center of the magnet. At the next revolution the particles rebound to find themselves in a field free region in the so-called magnetic deflector (B, Fig. 1) which allows them to escape from the pole pieces of the electromagnet. The slightly divergent beam proceeds in an evacuated tube to an external magnetic focusing field (C, Fig. 1) which bends them toward the exposure room (D, Fig. 1). Here, the particles go through a thin aluminum window and emerge as a well collimated, approximately monoenergetic beam. Since only about 1 per cent of the internal beam is deflected, considerable fast neutron and gamma-ray background is also present. A heavy concrete shield surrounds the cyclotron, decreasing the neutron and gamma-ray background to a low level in the exposure room. The exposure room is shielded on all sides with additional concrete. All biological exposures were done on a specially constructed treatment table (E, Fig. 1 and 2) operated from a remote control station (F, Fig. 1 and 3).

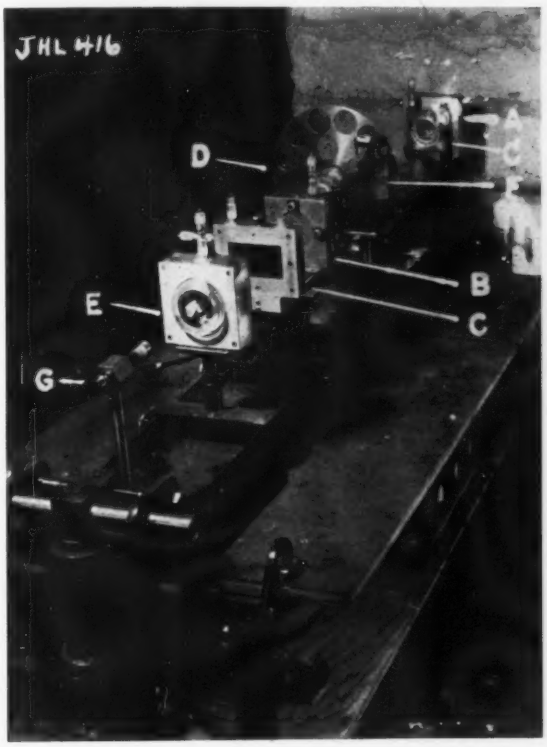

Fig. 2. Photograph of the irradiation bench. The irradiation bench consists of a set of two tracks approximately 8 feet long mounted on a suitable table. Its chief purpose is to support instruments for the measurement of physical properties of the beam and small animals during exposure. Usually it supports some ionization chambers which indicate whether or not the beam passes along the axis of the radiation bench, located 8 inches above the center of the track. It is possible to raise or lower and tilt the irradiation bench by remote control until the beam is exactly aligned with the bench. Also shown is the limiting aperture A, quadrant chamber B, monitoring chamber C, a set of absorbers in a so-called "absorber wheel" remotely controlled D, an analyzing chamber of similar type to the Failla extrapolation chambers E, and a lucite box suitable for holding mice F. At the end of the bench is a telescope pointing down along the beam axis G. This telescope is used for exact alignment of portions of animals to be irradiated.

The electrical controls on the cyclotron

FIG. 3. Remote control station. Located outside of the shielded area, the operator is able to control the position of the irradiation bench electrically and check continually that it is lined up with the external beam. It is also used for dose rate and accumulated dose determinations.

allow focusing the beam in a definite position and direction as well as stable fixation of the focused beam for several hours in the same position and direction.

The cross section of the beam available for biological study may be varied with suitable apertures from 2 inches in diameter down to any smaller size. The average operating deuteron beam current density is 1.6×10^8 particles cm.$^{-2}$ sec.$^{-1}$ corresponding to a soft tissue dose rate of 1,200 rep* per min. The highest dose rate used was 4,000 rep/min. with an instantaneous dose rate during individual pulses of 2.8 million rep min^{-1}. The helium ion beam intensity is lower by a factor of about ten, the 340 mev. proton intensity higher by a factor of two.

PHYSICAL MEASUREMENTS

We wish to report here results of the following measurements:

I. Ionization and dose distribution as a function of absorber thickness.
II. Beam current as a function of absorber thickness.
III. Stopping power measurements.

The measurements are usually conducted in the following fashion: After the resonance conditions in the cyclotron have been established, the beam is allowed to pass through an aperture sufficiently small to cut out a fairly uniform section (Fig. 4); then the treatment table is aligned so that the beam passes exactly along the axis of the monitoring instruments. Alignment is accomplished by adjusting the position of the table by remote control. The position

* 1 rep = 93 ergs/g.

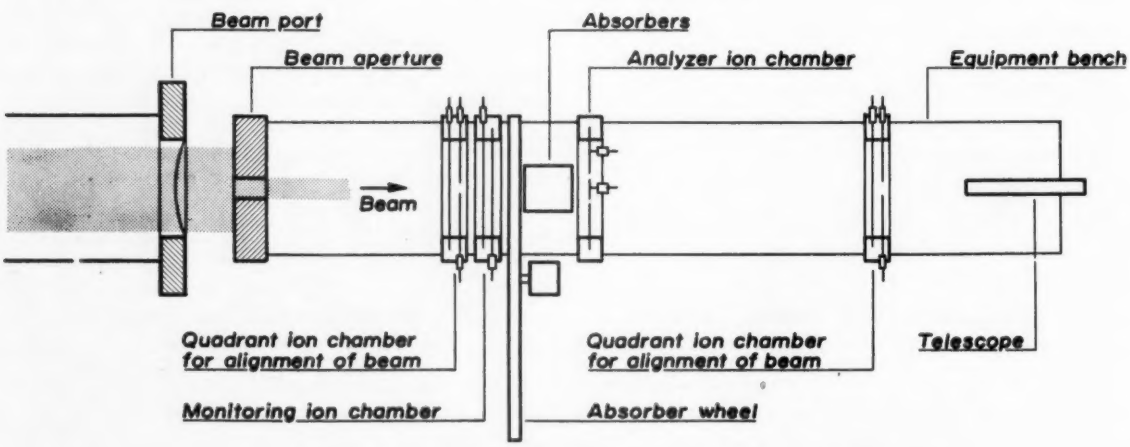

FIG. 4. Schematic arrangement of instruments for study of ionization.

of the table is indicated at the control station by two "quadrant" ionization chambers which have been described in reference 17 (Fig. 4). When the table is aligned, ionization chambers are placed on it for dosimetry. Usually the beam passes first through a monitoring ionization chamber (Fig. 4). The collecting electrodes in this chamber are larger than the cross section of the beam. Behind the monitor may be placed absorbers of various thickness and atomic number, conveniently mounted on a remotely controlled "absorber wheel" (Fig. 4). Behind the absorber is the "analyzer ion chamber" (Fig. 4) for total ionization measurements. The analyzer is similar to the monitor; for dose measurements the analyzer usually has a well defined small ion collection volume. If the beam intensity, that is the number of particles in the beam, is to be measured, the analyzer is a Faraday cage of special design.

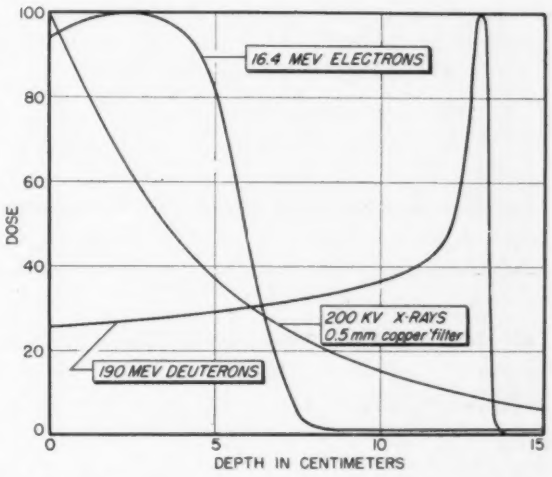

Fig. 5. Comparative ionization in air of three different radiations as a function of absorber thickness. The 200 kv. roentgen-ray curve is taken from Glasser, Quimby, Taylor and Weatherwax,[37] *Physical Foundations of Radiology*, page 225. The ionization as a function of depth of 16.4 mev. electrons has been measured originally by L. S. Skaggs *et al.*[9] The ionization curve for 190 mev. deuterons was measured in the present work. Note that as far as the ratio of depth dose to surface dose is concerned, the deuteron beam is superior to the other two radiations, indicated by ratio of approximately 4:1. The peak ionization for the 190 mev. deuterons lies at absorber thickness approximately 13.5 grams/cm^2. in lucite which is similar in composition to soft tissue.

PHYSICAL PROPERTIES OF 190 MEV. DEUTERONS

Ionization. When it was certain that the ionization chambers collect all ions formed by the beam in their sensitive volume by taking a plateau curve, the ionization of deuterons in air was measured when the beam passed through various absorber thicknesses. The variation of ionization versus thickness of lucite absorbers is plotted in Figure 5. For purposes of comparison, the ionization of 200 kv. roentgen rays and of 16 mev. electrons is also plotted on the same graph. The advantages of the deuteron beam for producing high ionization at a considerable depth are clearly indicated. The ratio of peak ionization to ionization at the point of entry in lucite, which is roughly equivalent to soft tissue, is about 4.1 for 190 mev. deuterons. This ratio, however, varies between 3.4 and 4.5 from day to day, due to variations in the homogeneity of the beam energy and it is higher if the cyclotron beam energy is held constant to a high precision. The experimental curve agrees very well with the predictions made by Wilson[14] for high energy protons.

Dose Distribution. It is reasonably easy to obtain measurements of the scattering properties of high energy particle beams. These measurements were made with a variation of the Failla extrapolation chamber. The isodose curves obtained by this method for an aperture size of 2.54 cm. diameter are shown in Figure 6. These curves are corrected for the stopping power of soft tissue. The actual isodose surfaces are obtained by rotating the curve in Figure 6 around the beam axis.

The increase of ionization with decreasing penetrating power is due to the increased rate of energy loss of the individual particles as their velocity decreases. The lack of excessive scattering may be photographically demonstrated. For this

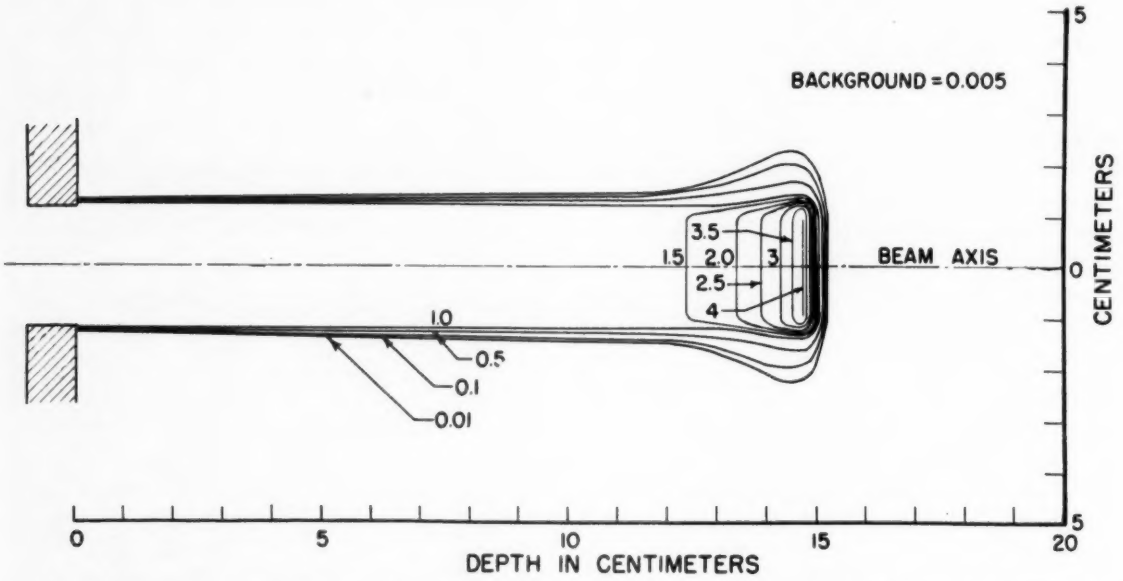

FIG. 6. Isodose curves plotted from actual measurements on a lucite phantom. The beam is limited by a circular aperture 2.5 cm. in diameter. Notice the sharp high peak of ionization, the very rapid drop of the dosage when the beam is near the end of its range, coupled with the low exit dose which is only 0.5 per cent of the dose at the skin. Scattering is almost completely absent from the point of view of dosage. The beam in some respects is similar to a straight pencil of radiation, with a peak of ionization at the end of the pencil. The spatial isodose surfaces are obtained by rotation of this diagram around the beam axis.

purpose, the deuteron beam was passed through an aperture ½ inch in diameter, then through a thick piece of aluminum with a photographic film behind it (Fig. 7). The increase in the effective diameter of the ionizing beam is very small. The experimental conditions are not favorable for determining the exact multiple elastic scattering coefficients.

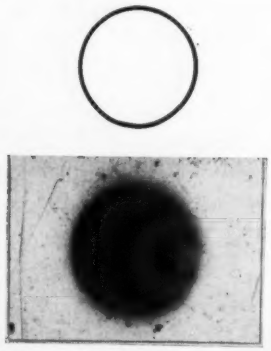

FIG. 7. Radioautograph of the deuteron beam that passed through an aperture ½ inch in diameter (shown on top of the figure) and subsequently through 17.5 g.cm.$^{-2}$ aluminum absorber. The outline of the beam is quite clearly defined. Note the absence of excessive scattering.

The above described characteristics give briefly the ionizing properties which should make high energy nucleon beams valuable in experimental radiology. Briefly, they may be summarized as: low skin dose, high peak dose at considerable depth, low scattering, and very abrupt fall off of ionization, both in the forward and lateral directions. An additional advantage is the great flexibility with which high energy nucleons may be used to achieve a wide range of dose distributions. It seemed clear to us that large doses of localized ionizing radiation could be placed at considerable depths in tissue with a much smaller surface skin dose.

VARIATION OF THE DEPTH AT WHICH THE MAXIMUM DOSE OCCURS

Using a cyclotron designed for monoenergetic ions, the depth of penetration in tissue may be decreased by using an ab-

sorber of appropriate thickness between the cyclotron and the body to be exposed. The entire ionization curve will shift in this case. The thickness of the absorber is chosen according to the required range of the beam in the tissue.

Another method that offers some advantage in reduction of straggling would be the use of particles with proper energy for each penetration desired. While this method is not available now it could be achieved in a machine expressly designed for medical purposes.

MAXIMUM AVAILABLE DEPTH DOSE

The ratio of depth dose vs. surface dose may be considerably increased by three different techniques: These are multiple port irradiation, rotational irradiation, and beam focusing. The ratio of depth dose to surface dose may be increased more than 100-fold in these ways. As an example, consider 360° rotation of deuterons in a 1 inch diameter beam around an axis coinciding with the peak of the ionization curve. This curve is often called the Bragg ionization curve in honor of Sir William Bragg who studied it for natural alpha emitters. Figure 8 gives the dose distribution in the plane of rotation for this case. Note the sharp increase in dose near the center of rotation. By varying the beam aperture from the circular form and combining different aperture shapes with rotation, it is possible to achieve dose distributions at any desired tissue depth to fit the shape of almost any desired volume to be irradiated.

It is possible to obtain a radiograph of the deuteron beam by placing a roentgen film in water with the film surface parallel to the direction of the beam. One obtains only a qualitative picture in this fashion. The blackening on the film is not exactly proportional to the ionization since the photographic film is relatively less sensitive to high specific ionization. Nevertheless such a picture was made and one is reproduced in Figure 9, showing the effect of the Bragg ionization curve combined with 120° rotation.

It is also possible, though this has not been done so far, to focus the deuteron particles so that they converge conically in a small area. This method also increases the ratio of depth dose to surface dose.

WIDENING OF THE HIGH DOSE PLATEAU

If the volume to be irradiated is thicker than the width of the Bragg ionization peak, simple methods are available to broaden the peak. In principle, a broad peak results from deuterons that have considerable energy distribution. In practice, one may insert a variable thickness absorber wheel in the beam before it reaches the body. As the wheel rotates during exposure, the effect of a broader maximum is obtained. Multiple port irradiation also gives the effect of a broader maximum if the ports are at wide angles.

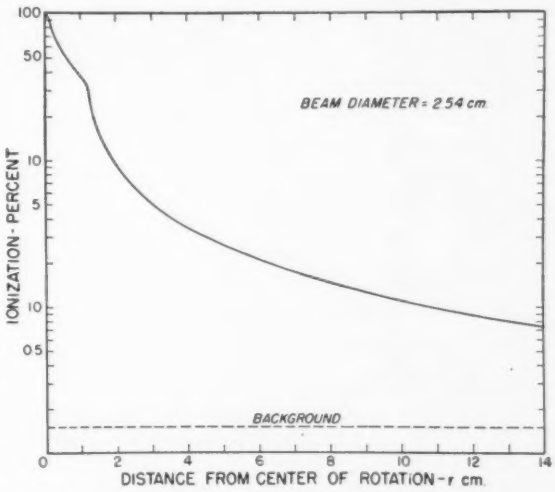

Fig. 8. Ionization distribution in tissue resulting from rotation of a 2.54 cm. diameter beam of 190 mev. deuterons in a plane 360° around a point. The center of rotation coincides with the peak of the Bragg curve. The manner of rotation is indicated on the graph. The curve plotted corresponds to ionization along any radius in the plane of rotation.

BEAM INTENSITY

As the parallel beam of ions accelerated in the cyclotron traverses tissue some of the particles are lost from the beam. They are lost partly by multiple elastic scatter-

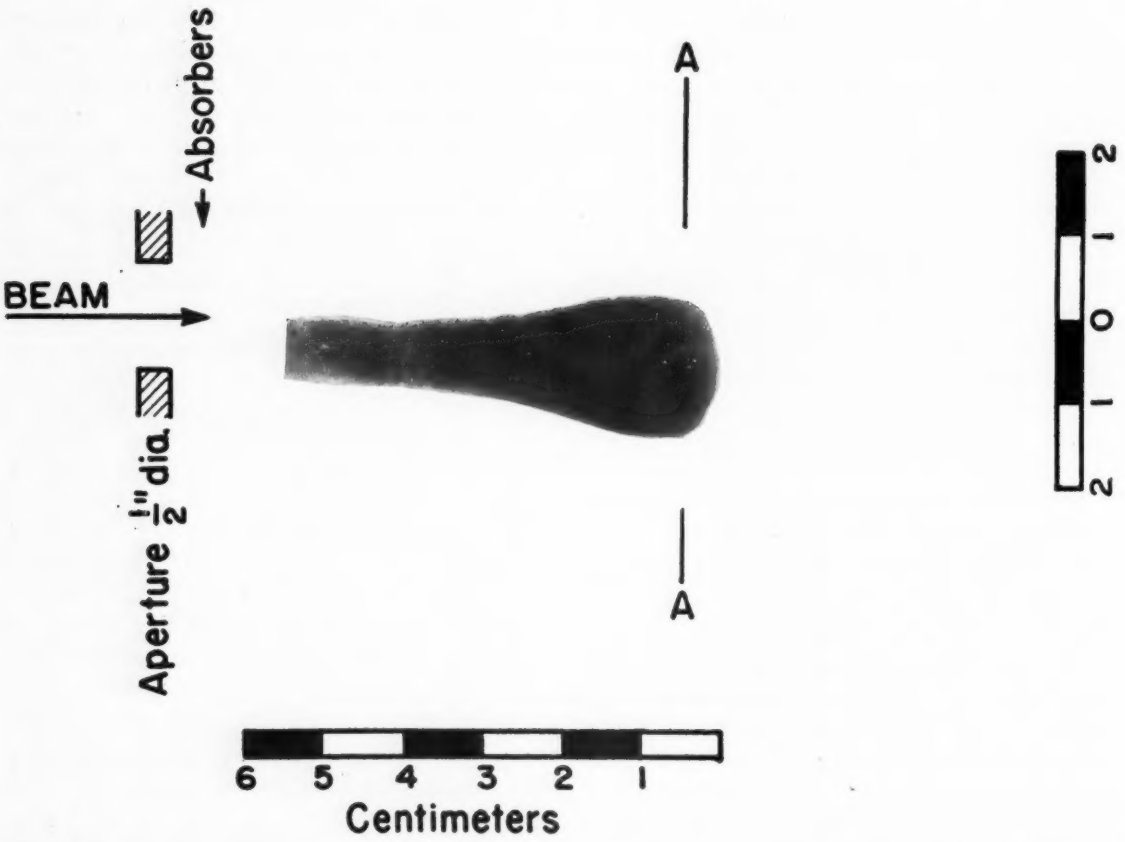

FIG. 9. Radioautograph of end of range of 190 mev. deuterons on roentgen film. The beam emerged through an aperture ½ inch in diameter. The commercial roentgen-ray diagnostic film was immersed in water and rotated slowly through an angle of 60 degrees around axis A–A while the picture was taken.

ing, but mainly by inelastic scattering resulting in nuclear transmutations. Before biological application of the beams was made it was necessary to attempt measurement of the absolute number of particles in the beam as well as their attenuation as it was related to the total ionization. For this purpose the analyzer of Figure 4 was a Faraday cage and a number of measurements were made to determine the number of deuteron particles that penetrated different absorber thicknesses. For polystyrene and aluminum a "Faraday attenuation" curve is plotted in Figure 10. One may notice that most of the particles penetrate almost the entire thickness of absorber, the slight initial slope of the curve being due to inelastic collisions. Near the end of the range, the number of particles drops rapidly but not precipitously because of the small amount of straggling present. Theoretically each particle having the same energy would penetrate the same depth in an absorber were it not for three different processes. The first process is the straggling of energy loss.

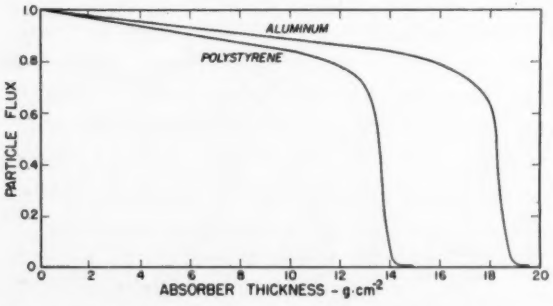

FIG. 10. Flux of high speed deuterons as a function of absorber thickness in aluminum and polystyrene (11.5 per cent H and 88.5 per cent C). The curves are quite similar for different elements and the range for various elements and tissue compositions may be quite accurately determined from the measured stopping powers.

Different particles traveling in a straight path have random statistical fluctuations in their ionization and rate of energy loss. The second cause for range distribution is multiple elastic scattering of deuterons by nuclei of the absorber. In this process the particles suffer many small impacts, each of them causing a slight change in the direction of the particles. The result is a slight spreading of the beam and a consequent shortening and statistical distribution of their range measured along the beam axis. The third cause of straggling is the loss of particles from the beam due to inelastic interaction of the beam particles with the nuclei of absorber atoms.

It was interesting to compare the measured mean range with the range given in the Range-Energy Tables prepared by W. A. Aron *et al.*[18] On the basis of this comparison the beam energy was determined to be 190 mev., assuming that the tables which were extrapolated entirely from low energy data were correct for the high energy ranges. This is in reasonable agreement with the only other independent method available at the present time for measurement of the beam energy, namely by estimation, from the radius of curvature of the ion path in the field of the focusing magnet.

From the slope of the end of the range distribution curve it is possible to calculate the root mean square fluctuation δR of the range [19]

$$\frac{\delta R}{R_m}=\frac{2}{\sqrt{\pi}}\frac{R_0-R_m}{R_m}\approx 0.017$$

where R_0 is the extrapolated range and R_m is the mean range. This may be compared to an approximate formula for the straggling of monoenergetic particles given by Wilson,[20] and based on Bethe's equation for energy loss.

$$\frac{\delta R}{R}\approx 0.24\,W^{-0.1}E_0^{-1/2}\approx 0.007.$$

Here W is the ratio of kinetic energy to rest energy of the deuterons and E_0 their rest energy expressed in mev.

The experimentally obtained straggling is about twice the theoretical value assumed for monoenergetic particles. By examination of the range energy formula one may conclude that the cyclotron deuterons must be quite monoenergetic. It is estimated that the energy spread of the beam is of the order of 1 mev. (0.5 per cent) or less.

The initial decrease in ion flux at low absorber thicknesses is due to inelastic collisions (Fig. 10). The accurate evaluation of the cross section for inelastic scattering and the angular distribution of the scattered particles is beyond the scope of this paper. However, during the past three years significant work has been done on this problem so that the salient facts are now quite well understood. At high velocities corresponding to a kinetic energy of 100 mev. per nucleon or higher, the nucleus itself becomes partially transparent as shown by Cook *et al.*[21] At low atomic number Z, the nucleus may be regarded as a collection of nucleons, capable of interacting individually with the incident particle. The mean free path of a 110 mev. nucleon in the nucleus is 3×10^{-13} cm., so that at higher Z, multiple nucleon-to-nucleon collisions occur in the nucleus. In a single nucleon-to-nucleon collision the energy loss is usually not more than 25 mev. Whether the process following the collision is the emission of a single particle or several particles depends on the interaction of the excited nucleon with the rest of the nucleus.[22] The yield of stars has been investigated in photographic emulsions with deuterons and high energy helium ions by Gardner and associates.[23] The mean prong number was found to be approximately 3 for each star in the emulsion.

When deuterons are used for tissue irradiation, it is quite possible to predict that the general type of particles in nuclear stars will be preponderantly protons, neutrons and alpha particles. The distance between the proton and neutron composing the deuteron nucleus is so large that often one of the nucleons gets into the target

nucleus while the other remains outside. This leads to the so-called stripping process in which the deuteron flies apart, thus giving rise to fast neutrons or protons. Either of these moves predominantly in the forward direction. The stripping process was proposed by Serber.[24] From the range of the products of star formation, their wide distribution at all angles, and their expected cross section it is estimated that the star prongs might contribute not more than 1 per cent to the ionization in air of 200 mev. deuterons, and to the particle current measured in the Faraday cage. The ionization and current measurements should thus be only slightly affected by the recoils produced in inelastic collisions. Attempts were made to detect such effects by obtaining differences in ionization when the ion chamber wall material was varied in atomic number. However, since the standard error in ionization measurements was about 1.6 per cent, no significant effects were observed due to ionization from nuclear stars. One may infer from this result that the biological effect of the nuclear stars is also lower than that of primary deuteron ionization though not necessarily lower than 1 per cent.

The inelastic cross section varies inversely with the energy. The slope of the Faraday cage curve was not steep enough for accurate cross section measurement. However, by extrapolation one obtains a figure of 5×10^{-25} cm.^{2} for aluminum above 100 mev. Below 100 mev. the total cross section is greater.

When enough absorber has been placed in the beam to stop all deuterons, there are still some ionizing particles left in the beam. They have about one half of 1 per cent of the ionizing value of the high energy particles. This ionization is chiefly due to recoils due to elastic collisions with the fast neutrons produced by the stripping and other inelastic processes. The ionization at absorber thickness greater than the range of the beam is of the same order of magnitude as general neutron background in the exposure room.

RATE OF ENERGY LOSS

Measurement of the Bragg curve and of the Faraday curve is of interest in radiobiological investigations because the use of these data allows determination of the specific ionization of the particles and from this the rate of energy loss. The specific ionization for single particles may be quite accurately calculated as a function of energy.[18] Due to straggling, multiple and inelastic scattering, the beam ceases to be monoenergetic as it is slowed down in an absorber. Correspondingly, one is able to calculate from the experimental data the mean ionization per particle which takes into account the finite energy spread of the beam at low energies. Figure 11 shows the experimentally obtained mean specific ionization curve in air with aluminum absorbers. A 30-fold increase in specific ionization is obtained as the particles slow down. The increase is steeper than the total ionization curve itself. Specific ionization and rate of energy loss are of great interest in radiobiology since it is known that the relative biological effectiveness of various radiations is a function of these quantities. Provided that one knows the energy required per ion pair produced, the specific ionization may be interpreted in terms of rate of energy loss as well. Assuming that the theoretical values for the rate of energy loss[18] are correct, we determined the value of W, the average energy required per ion pair, by simultaneous ionization and beam current measurement and found it to be 32.5 ev. for dry air at STP.

W is approximately constant for the entire energy range down to 10 mev. deuterons. More recently Bakker and Segre determined W values[25] with 340 mev. protons in a number of gases.

The specific ionization of the doubly ionized 380 mev. α-particles varies in a fashion similar to deuterons along their path; the range of these particles is one-half that of 190 mev. deuterons and the specific ionization four times that of deuterons with the same velocity. Bragg

curves and Faraday cage curves are available for these particles. It should be pointed out that different sources of the high energy deuterons and alpha particle beams afford means for the experimental study of biological effects on small organisms with a 300-fold variation of mean rate of energy loss. Work along these lines is in progress.

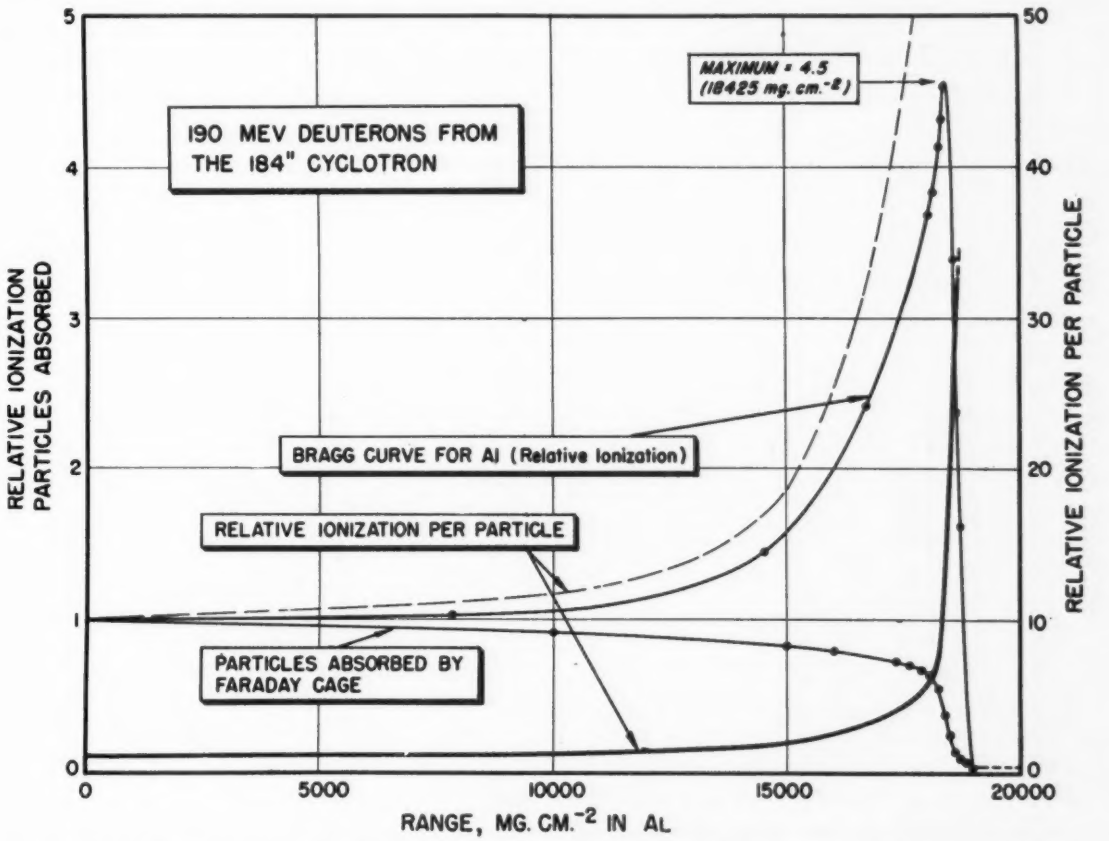

Fig. 11. Relative ionization and relative number of deuterons through aluminum absorbers of varying thickness. The ratio of these gives the mean specific ionization which is plotted in arbitrary units. Observe a sharp increase of the relative ionization per particle at the end of the range.

DOSIMETRY

The use of the traditional roentgen unit is not convenient with high energy ion beams. We are dealing with a radiation that has a very inhomogeneous distribution in space. Six different units of dose were found to be satisfactory in the interpretation of biological effects caused by such beams. Some of these are natural extensions from dosimetry of other radiations. The concept and terminology may be applied to a number of radiations. We shall discuss each unit separately.

(1) *The beam current*: (*I*) This may be expressed in ampere units or in terms of particles per second and corresponds to the electric charge of all high energy ions impinging on the biological specimen per unit time. The beam current may be measured directly using a Faraday cage.

In the measurements reported here, the charge $\mathcal{Q}$ collected by the Faraday cage has been measured in terms of potential change V caused at the plates of a condenser of known capacity C in time t. The measurement of voltage was made with a slideback voltmeter:

$$\mathcal{Q}=CV$$

the current:

$$I=\frac{dQ}{dt}=C\frac{dV}{dt}. \qquad (1)$$

If the rate of change in potential is measured in volts/sec., and C in farads, one obtains the beam current in amperes. The number of particles which pass a given point per unit time is obtained by dividing I by the particle charge ze in coulombs.

$$\frac{dn}{dt}=\frac{I}{ze}=\frac{C}{ze}\frac{dV}{dt}. \qquad (2)$$

(2) *The beam current density or flux of particles per unit cross section and unit time* (F). The beam current density expressed as amperes cm.$^{-2}$ or as particles cm.$^{-2}$ sec.$^{-1}$ is usually not uniform over the entire cross section of the beam. It has a distribution which reaches a constant maximum at the center of the beam and falls off at the edge. For complete determination of the beam the entire spatial dependence of the current density is needed.

Figure 12 shows flux distributions obtained with the extrapolation chamber at various absorber thicknesses. However, it seems sufficient for most purposes to obtain the peak flux at the center of the aperture since the variation of flux at the edge of the beam is due to scattering and may be estimated for given geometrical conditions. A special ionization chamber was developed for measurement of the flux of particles. This chamber measures the ionization from particles going through an area prescribed by the size of the collecting electrodes.

Let F be the beam current density, F^* the particle flux and i the measured ionization current in an ionization chamber filled with nitrogen and having a sensitive volume v. Assume p_0 to be the specific ionization in terms of ion pairs per particle per cm. of STP nitrogen.

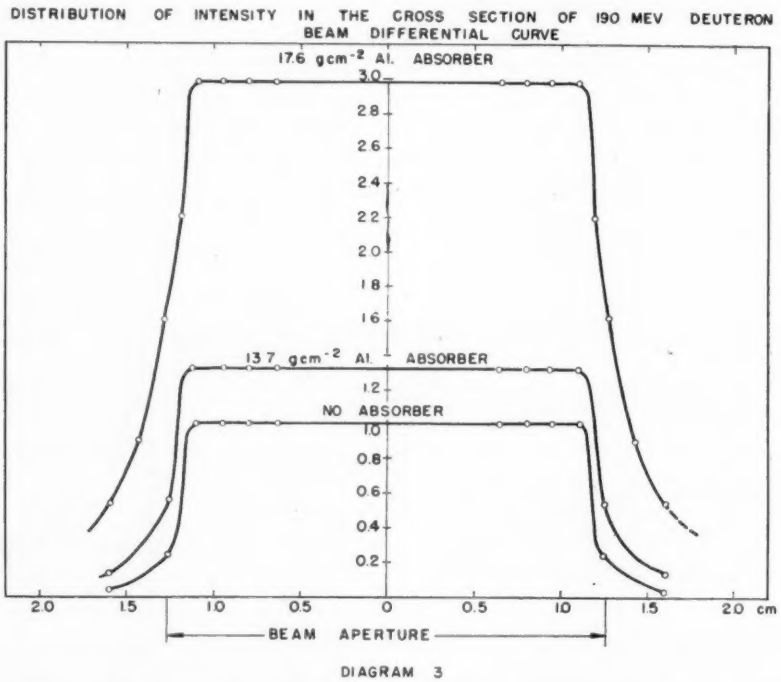

FIG. 12. Distribution of deuteron beam current density at three different absorber thicknesses, in arbitrary units. Beam aperture circular, 1 inch diameter.

$$F=\frac{i}{vp_0}\ (\text{amp cm.}^{-2}),$$

$$F^*=\frac{i}{vp_0e}\ (\text{particles cm.}^{-2}\ \text{sec.}^{-1}),$$

(e = charge of electron).

(3) *Specific rate of energy transfer* (R). This is the energy transferred by the beam to a unit mass of tissue of known composition in unit time. It may be obtained by multiplying the particle flux by the rate of energy loss of each particle in the tissue. The specific rate of energy transfer has the same meaning as the dose rate expressed in rep/sec. or gram roentgen/g. sec. units. Conveniently it is measured in terms of mev. $g.^{-1}sec.^{-1}$ but it is also easy to express it in terms of other units. From the specific rate of energy transfer of high energy deuterons at a well defined point in the beam, it is possible to calculate specific rate of energy transfer for any other point in homogeneous tissue provided the isodose curves discussed in section 1 are available. For a given aperture size the isodose curves are modified for inhomogeneous tissue only by the variations of density and stopping power of tissue and these depend on tissue composition and geometrical distribution of organs. If the stopping power is known for each point in the irradiated tissue, isodose curves may be approximately calculated for any distribution of tissue without having to measure them out each time in phantoms.

Knowledge of the density of ion chamber gas d_g, and the energy required per ion pair W_g yields the specific rate of energy transfer R_g to the gas.

$$R_g=\frac{i\cdot W_g}{vd_ge}=F^*\cdot r_g. \tag{3}$$

Here r_g is the rate of energy loss (REL) of each particle in ev. for each g.cm.$^{-2}$ of gas traversed.

$$r_g=\frac{W_gp_g}{d_g}=\frac{NZ_g\epsilon_g}{A_g}. \tag{4}$$

Here N is Avogadro's number, Z_g and A_g are atomic number and atomic weight of the chamber filling gas respectively and ϵ_g is the rate of energy loss for each particle per cm.^{2} per electron in the gas. For any other element with constants, Z, A, ϵ the rate of energy loss r is given by

$$r=r_g\frac{ZA_g}{Z_gA}S_e \tag{5}$$

where $S_e=\epsilon/\epsilon_g$ is the relative electronic stopping power. Knowledge of the relative electronic stopping power is thus necessary for determination of the specific rate of energy transfer in tissue from gas ionization measurements. For tissues of complex composition, having $\alpha_1,\alpha_2,\cdots,\alpha_k$ percentages by mass of elements with atomic numbers $Z_1, Z_2,\cdots, Z_k$ we have used the expression

$$r=\frac{r_gA_g}{Z_g}\sum_{j=1}^{k}\frac{\alpha_j}{A_j}S_{ej}Z_j \tag{5a}$$

so that finally the specific rate of energy transfer in tissue, R, from gas ionization measurement, turns out to be

$$R=\frac{iW_gA_g}{vd_geZ_g}\sum_{j=1}^{k}\frac{\alpha_jS_{ej}Z_j}{A_j}=\frac{i\cdot W_gr}{v\cdot d_gr_g}. \tag{6}$$

The nuclear physicist would use R in units of ev. $sec.^{-1}$ $g.^{-1}$, with i in amperes, and W electron volts/ion pair. Multiplication by 1.602×10^{-12} gives R in units of (erg $sec.^{-1}$ $g.^{-1}$) and further division by 93 yields R in units of (rep $g.^{-1}$ $sec.^{-1}$).

The method of averaging stopping power is not completely justified, since some recent experiments[24] seem to indicate that molecular stopping power is not a simple average of atomic stopping powers. However, until more definite confirmation is forthcoming the above figure may be conveniently used. In any case, corrections in stopping power due to molecular interaction would be small. Measurements of stopping power will be discussed in a later section.

(4) *Specific energy transfer* (S). This term corresponds to the total energy received by a gram of tissue during the entire period of irradiation T. It may be obtained by integrating the specific rate of energy transfer over time. It may be expressed in mev./g, ergs/g, rep or gram roentgen/g units.

$$S=\int_0^T R dt=\frac{W_g}{v_g d_g e}\,\frac{r}{r_g}\int_0^T i dt=\frac{W_g r \mathcal{Q}}{v_g d_g r_g e}. \quad (7)$$

$\mathcal{Q}$ is the total charge collected by the ion chamber in time T.

(5) *Total number of high speed particles* (n) *and density of particles* ($dn/d\sigma$). The total number of high speed ions is particularly useful when comparisons with the "target" theory of radiation effects are made. Measurement is obtained with the Faraday cage. From (2)

$$n=\int_0^T \frac{dn}{dt}dt=\frac{C\cdot V}{z\cdot e}. \quad (8)$$

Even more useful is the expression of particle density per unit cross section of the beam, $dn/d\sigma$. This is obtained from the specific energy transfer and the mean rate of energy loss of the particles, equations 7 and 5

$$\frac{dn}{d\sigma}=\frac{S}{r}=\frac{\mathcal{Q}W_g}{v_g d_g r_g e}. \quad (9)$$

(6) *The energy transfer* (U). The energy transfer is the energy transferred to the entire body of the animal by the beam in the entire course of treatment. This is measured in terms of ev., ergs, or gm. roentgens. This quantity would be usually obtained by integrating the specific energy transfer, S, for the whole mass m of exposed tissue

$$U=\int S dm. \quad (10)$$

The isodose curves are so much alike that it is sufficient to know the aperture size, the rate of particle flux as measured in the monitoring ion chamber and a spatial distribution of different types of absorbers and tissues. In practice we have used total energy transfer together with the mass of the animal body irradiated as per cent of body mass. Often a simpler expression than (10) may be satisfactory if E is used to denote the energy of the high speed ions as they enter the tissue

$$U\approx n\cdot E. \quad (11)$$

The above expression is only approximate because some particles suffer inelastic collisions and produce secondaries. Part of the disintegration recoils produced will produce ionization in tissue, while the other part may escape as neutron or gamma radiation.

DETERMINATION OF ELECTRONIC STOPPING POWER OF DEUTERONS

The range of the particles was determined in aluminum, the standard substance to which the relative stopping power of other elements was referred. The monitoring ionization chamber was used to measure the beam intensity, and the number of particles going through a given thickness of absorber was measured by the Faraday cage. A complete Faraday cage curve for aluminum is shown in Figure 11, yielding the value of 18.425 g.cm.$^{-2}$ for mean range and 18.707 g.cm^{-2} for the extrapolated range of 190 mev. deuterons. A relatively small part of the aluminum absorber, equivalent to slowing the ions to 170 mev., was then removed and a known thickness of another metal with different

TABLE I

MEASURED AND CALCULATED STOPPING POWER OF VARIOUS ELEMENTS FOR 180 MEV. DEUTERONS

Element	Z	$\frac{Sz}{S_{AL}}$	$\frac{Sz^*}{S_N}$
H†	1	1.25	1.18
Be	4	1.11	1.047
C	6	1.08	1.02
N*	7	1.06	1.00
O†	8	1.045	0.986
Al‡	12	1.000	0.943
Fe	26	0.9205	0.868
Cu	29	0.915	0.863
Mo	42	0.8475	0.7395
Sn	50	0.823	0.776
Ta	73	0.767	0.724
Pl	82	0.747	0.707
U	92	0.726	0.685

* The nitrogen value was interpolated from the values for O$_2$ and C. The last column was added to make comparisons with ionization chamber measurements easy. The ion chambers are usually filled with nitrogen.

† Calculated from data on water, lucite and polystyrene.

‡ Standard basis of comparison.

atomic number Z was substituted. The range of the deuterons was now measured through the combined absorber consisting of aluminum and the substituted metal. From these data, equivalent thicknesses of aluminum and the substituted metal were calculated. From this the relative stopping power per electron was obtained. The final data are plotted in Figure 13 where the relative electronic stopping power compared to aluminum is shown as a function of the atomic number Z, Z being plotted on a logarithmic scale. Beginning with the element Fe there is a straight line relationship between the electronic stopping power and the logarithm of Z. Below Fe the relationship is not as simple. Theoretically there is no particular reason why all the points should lie on a completely smooth curve. Table 1 shows the results of the measurements and the calculated stopping power. In the usual theory, the Thomas Fermi Statistical model of the atom is used in calculating the theoretical rate of energy loss. According to this theory the ionization potential, which may be deduced from the stopping power measurements, is exactly proportional to the atomic number at high Z. According to the present experiments there is no strict proportionality with the atomic number; rather the ionization potential is proportional to the 1.1 power of the atomic number. The deviation is not great enough to change the theoretical range and above $Z=25$ the assumption $I=9.5\ Z$ volts still fits the data reasonably well. The discrepancy should be more apparent when billion volt parti-

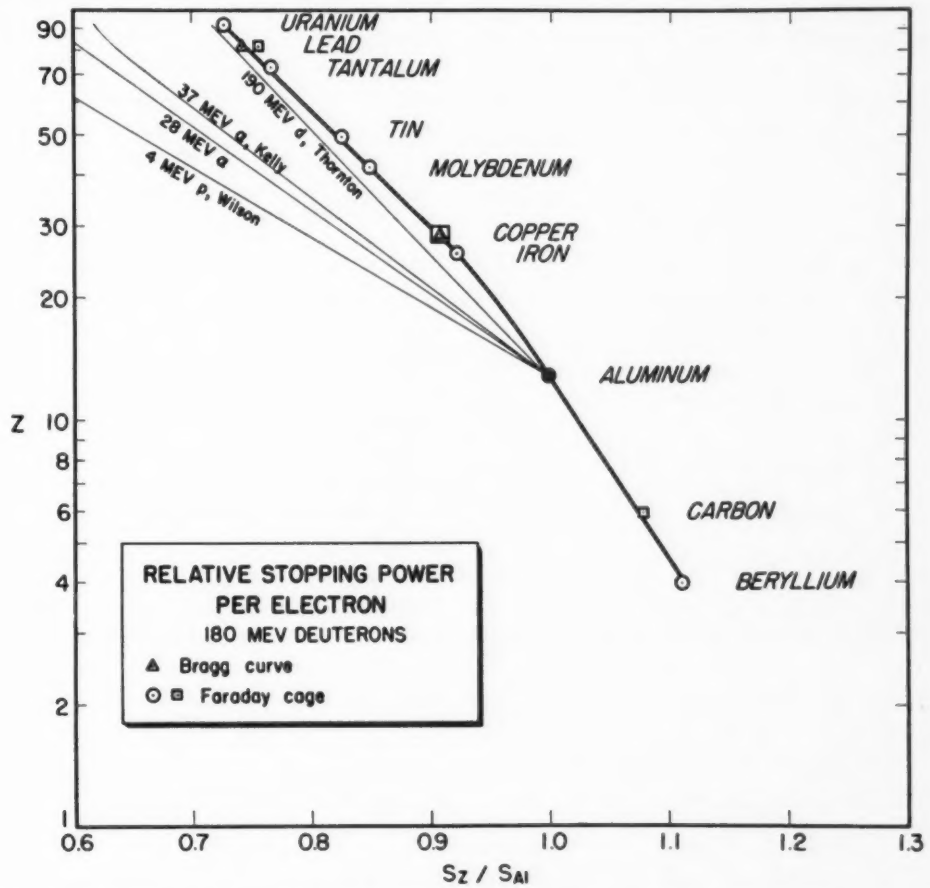

Fig. 13. Relative stopping power per electron of 180 mev. deuterons with respect to aluminum, as a function of the atomic number.

cles are available, and it will play a role in the range energy determination of the high energy particles.

Having obtained the electronic stopping power, it is now possible to calculate the equivalent stopping power per gram of different types of tissue of known composition and density. These values may be used immediately in dosage calculations.

TABLE II

STOPPING POWER OF 180 MEV. DEUTERONS FOR VARIOUS TISSUES

Medium	Composition in % Mass								Effective Atomic Number Z	Relative Electronic Stopping Power	Relative Mass Stopping Power	Energy Loss of 180 Mev. Deuterons
	H	C	N	O	P	S	Ca	Other Z=16				
Aluminum	—	—	—	—	—	—	—	—	13	0.94	0.91	6.0 mev./g. cm.^{2}
Nitrogen‡	—	—	100	—	—	—	—	—	7	1	1	6.6
Water	11.1	—	88.9	—	—	—	—	—	5.6	1.02	1.14	7.52
Soft tissue* (wet)	10	12	4	73	0.2	0.2	0.01	0.59	5.3	1.024	1.136	7.5
Virus protein* (dry)	7	49	16	25	1	0.5	—	1.5	4.4	1.04	1.03	6.8
Wet bone†	4	17	5	48	5	0.2	20	0.8	4.8	1.03	0.94	6.2

* Composition from ref. 27, p. 7.
† Composition calculated on basis of ref. 28, p. 625.
‡ Relative stopping power assumed to be unity, since the energy loss in nitrogen may be directly estimated from ionization measurement.

Table II gives the values for soft tissue, dry protein and bone. There is some difference in the manner of stopping high energy charged particles compared to low energy roentgen rays. Bone usually absorbs more energy when exposed to low energy roentgen rays than does soft tissue. Materials with high atomic number usually absorb more energy than low Z materials when they are exposed to low energy roentgen rays since the photoelectric absorption coefficient is proportional to Z^3, the Compton and pair production coefficients to Z. In the case of deuterons, protons or alpha particles the energy absorbed per gram of high atomic number material is often less than that per gram of low atomic number material because the stopping power per electron is less for high Z than for low Z. Table II shows that in a deuteron beam bone absorbs actually slightly less energy per gram than a gram of soft tissue placed in the same portion of the beam. In certain therapeutic procedures where bone has to be in the path of the radiation, this circumstance may be of some advantage, since bone is a fairly radiosensitive tissue. The present data add to the information available in the literature at various particle energies consisting of determinations of Wilson[26] for 4 mev. protons, of Kelly and Segre for 15 and 37 mev. alpha particles,[29] Stephan and Thornton for 180 mev. deuterons,[30] and Bakker and Segre[25] for 340 mev. protons.

RATE OF ENERGY LOSS AND RELATIVE BIOLOGICAL EFFECTS

It is well established that when animal tissues are irradiated, ionizing particles with a high rate of energy loss have a relatively higher biological effect than particles with a low rate of energy loss.[32] The ratio of the doses required to produce the same biological effect (or the so-called relative biological effectiveness, R.B.E.) may be as great as 10 to 1 with fast neutron recoils as compared to roentgen rays. On the other hand, in different biological tissues the R.B.E. may be different for a given particle. In some cases even a decrease of effective-

ness is found with increasing REL (rate of energy loss). It is worth while to make a comparison of the mean rate of energy loss available at various portions of the deuteron and alpha particle beam with the rates of energy loss of other radiations used at the present time. The rate of energy loss of 190 mev. deuterons per gram soft tissue is about 6.52 mev./g. This rate of energy loss is about the same as the rate of energy loss of 45 kv. electrons. Forty-five kilovolt electrons may be assumed to have the energy of a typical secondary electron from 200 kv. roentgen rays. We thus make the interesting deduction that the relative biological effectiveness of 190 mev. deuterons is expected to be approximately the same as the relative biological effectiveness of 200 kv. roentgen rays. As the deuteron beam penetrates an absorber, the deuterons lose energy but the mean rate of energy loss increases only at a slow rate. When the peak of the Bragg ionization curve is reached, just before the end of the range, the deuterons have a mean energy of 25 mev., and correspondingly the mean specific ionization is 48 mev./g. cm^{-2}. Review of the data recorded in the literature on fast neutron effects indicates that in most of the biological experiments with these fast neutrons the experimenter used neutrons of mixed energy. Most recoils from such neutrons may be estimated to be of relatively low energy, *e.g.*, fast neutrons from a chain reacting pile have a mean energy of approximately 4 mev. Considering the available information, it may be conjectured that the R.B.E. for lethal effect on tissue cells should be not very different from unity at the Bragg ionization peak, but might increase rapidly to a factor of about 10 as the particles slow to a stop. On this basis the R.B.E. of fast deuterons remains close to unity over 95 per cent of their range.

LETHAL EFFECTS OF HIGH ENERGY DEUTERON AND PROTON BEAMS

Since the range of 190 mev. deuterons is about 6 inches in soft tissue and the range of 340 mev. protons is even longer (approximately 28 inches), it was possible to study the lethal effect of whole body irradiation on white laboratory mice. The animals were placed in a beam which was substantially uniform in flux over its diameter of $1\frac{1}{4}$ inches. The particles passed through the entire body with substantially the same specific ionization. The mice were enclosed in plastic tubes of 1 inch diameter and 1/16 inch thickness. Each mouse was placed with the head toward the beam. For one experiment, strain "A" mice were used (480 animals), and for another, Bagg albinos (270 animals). Doses were administered of 180 mev. deuterons, 340 mev. protons, and 200 kv. roentgen rays. The deuteron energy decreased to about 120 mev. at the exit from the mice. Fifty per cent mean lethal doses for a thirty day period were studied. From Table III, it may be seen that there was no significant difference between the three radiations. The weight loss with deuterons and protons was very similar at equal survival ratios to those of roentgen rays. The survival curves had typical shapes resembling data obtained with roentgen rays. The gross symptoms and signs of the mice were typical for radiation sickness. A significant percentage had diarrhea and hemorrhage, which was evidenced by bloody diarrhea. Many of the mice lost weight very rapidly just prior to death, and before death occurred their fur was ruffled. Dr. Paul Rosahn made some histological studies of the various tissue sections obtained from mice irradiated with deuterons at various dose levels. Blood studies were also carried out. These data are being reported in a separate paper.

The results were expected and found to be approximately the same for 200 kv. roentgen rays, deuterons and protons. The timing of roentgen rays and deuterons was different; the roentgen rays were obtained in 60 cycle rectified AC waves; the deuterons in 90 pulses per second each of approximately 10–15 microsecond duration. Some attempt was made to correlate the mean

dose rate to the lethal dose, and from preliminary data it appears that higher dose rates result in a slightly higher and more rapid lethal effect.[17] However, the many factors which influence the survival of mammals after a dose of radiation makes the last conclusion preliminary and subject to

TABLE III

COMPARISON OF ACUTE LETHAL DOSE OF MICE FOR ROENTGEN RAYS, 190 MEV. DEUTERONS AND 340 MEV. PROTONS
50 PER CENT L.D.—30 DAYS

	I	No.	SET	SRET	ET	REL	RBE
Type of Radiation	Mouse strain	of mice in experiment	Specific energy* transfer (ergs/g)	Specific rate of energy transfer (ergs/min)	Energy transfer ergs	Mean rate of energy loss (soft tissue) mev.$^{-1}$ gm.^{2}	Relative biological effect (compared with roentgen rays)
180 mev. roentgen rays	Bagg albino	120	6.6×10^{4}	2.6×10^{3}	1.6×10^{6}	8.0 (approx.)	1
	"A"	120	5.8×10^{4}	2.6×10^{3}	1.4×10^{6}		1
160 ± 30 mev. deuterons	Bagg albino	120	5.5×10^{4}	2.10^{5}	1.4×10^{6}	7.4	approx. 1
	"A"	270	5.6×10^{4}	5.10^{4}	1.3×10^{6}	7.4	approx. 1
315 ± 15 mev. protons	"A"	90	6.2×10^{4}	2.10^{4}	1.4×10^{6}	5.77	approx. 1

* 1 rep = 93 erg/g^{-1}.

further study. The acute lethal experiments conducted with the high energy deuterons indicate that qualitatively and quantitatively the gross biological effect of high energy nucleons on white mice is quite similar to that of roentgen rays. This is of course not true when the low energy portion of the beam is utilized.

PRELIMINARY STUDIES OF RADIATION EFFECTS ON MOUSE TUMORS

It seemed worth while to carry out a few experiments to localize the ionization of the deuterons in some tumors. These experiments have given some indication of the possible future medical usefulness of high energy ion beams.

The choice of the experimental animals was somewhat difficult. It is of advantage to use as large an animal as possible for two reasons: (1) The size of the tumor at the time of irradiation should be small compared to the size of the animal. If this is the case the tumor may be reached by a pencil of radiation without having to irradiate too large a part of the body of the animal. (2) The size of the tumor should be larger than 0.6 cm. because the beam will scatter out to at least this diameter as it passes through the body of the animal, even if very small beam apertures are used. Both of these conditions favor the use of rabbits over rats or mice. The Brown-Pearce carcinoma available in rabbits, however, spontaneously regresses and fails to cause lethal effects in a large percentage of the animals. Since clear-cut evidence of the radiation effect was needed, mice were used in the first experiment. The data reported here refer throughout to Strong A strain mice carrying a transplantable mammary carcinoma.[31] This strain and tumor originally given to us by Dr. Strong

have been carried on for over fifteen years in the Donner Laboratory and with care there are 100 per cent "takes" among the transplants and 100 per cent of the mice having such tumors die from the carcinomas. At the beginning of these experiments it was quite clear that one could not hope for a 100 per cent regression of tumors after half of the animals, in agreement with the observations of Lawrence *et al.*,[32] for 200 kv. roentgen rays and 8 mev. neutrons. 3.3×10^5 erg/g. appeared to have retarded the tumor growth only for a limited time period. Figure 14 indicates the weight loss of some of these animals and their survival time as compared to controls.

Table IV

Results of deuteron irradiation of mammary carcinoma in "A" mice
(Body of the Mice Shielded and the Tumor Exposed)

Group	Peak Specific Energy Transfer in Tumor erg g^{-1}	Per Cent Body Mass Exposed	Energy Transfer ergs	Number of Animals	Permanently Recovered with Complete Regression of Tumor Per Cent	Died Apparently Due to Tumor Growth Per Cent	Died Apparently Due to Radiation Effects Per Cent
I	Controls	0	0	40	2.5	97.5	0
II	3.3×10^5	7	0.54×10^6	5	0	100	0
III	6.7×10^5	7	1.08×10^6	19	42	53	5
IV	9.8×10^5	7	1.6×10^6	18	33	50	17
V	13×10^5	7	2.1×10^6	19	50	44	6
		Tumors Exposed Through the Body of the Mice					
VI	9×10^5	20	2.5×10^6	20	25	60	15
VII	11×10^5	20	3.1×10^6	20	20	18	62

the treatment since several conditions had to be rigorously fulfilled. The tumor had to be irradiated over its entire volume; at the same time the body should not receive more than a moderate dose. These conditions are only partially satisfied in the mice where the skin lying over the tumor will unavoidably receive much radiation. Metastasis of the tumor also might influence the outcome. Using small numbers of mice (there was only limited cyclotron time available), the tumor lethal dose was first established. This was done by pulling the entire tumor, enclosed in a skin fold, away from the body of each animal and endeavoring to direct the beam in such a way that only the tumor and the skin fold would be hit, the rest of the body being avoided. Table IV shows the results, and it was found that specific energy transfer of 6.7×10^5, 9.8×10^5 and 13×10^5 ergs/g. can cause complete regression in about one-

The principle which we hoped to demonstrate in a practical way was that by the use of deuterons, protons, or alpha particles it is possible to administer a larger amount of energy to a tumor than to the normal tissues of the animal lying between the tumor and the radiating device. Since the mouse tumors were transplanted under the skin, in the next experiments the mice were placed in such a way that the deuteron beam had to pass through their lungs first before reaching the tumors. The regression dose of the tumor was several times the lethal dose for whole body irradiation of the animals, and therefore it was decided to further enhance the effectiveness of the treatment by a technique equivalent to multiple port irradiation. The tumors of the animals were fixed in space and the animals themselves were rotated slowly around the tumor, describing an arc of 120 degrees. This allowed distribution of the beam in the

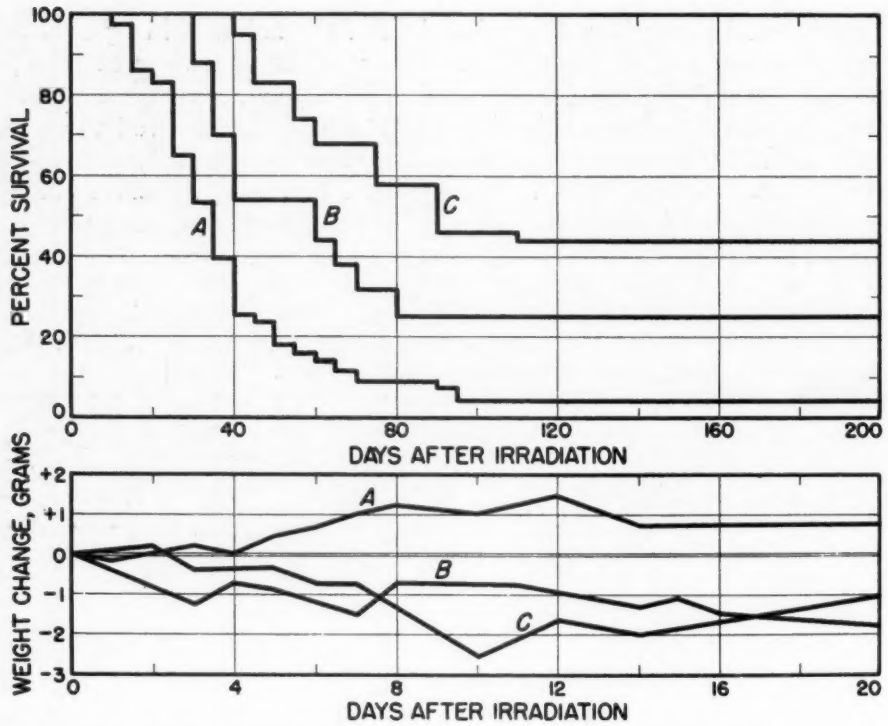

FIG. 14. *Upper Graph:* (A) Survival of A mice with transplanted mammary carcinoma, not treated with radiation. (B) Survival of tumor mice treated with deuterons through their body (Group V, Table IV). (C) Survival of tumor mice treated with deuterons passing only through tumor and the skin enclosing it (Group III, Table IV).

Lower Graph: Weight loss of Groups A, B, C after irradiation.

animal body outside of the tumor and also increased the probability that the most ionizing part of the beam would hit the tumors uniformly. The mice were placed in a lucite tube in a vertical position, anesthetized, and partially immersed in water at body temperature. The tumor was aligned in the center line of the cylindrical water bath. Absorbers were placed in the path of the deuteron beam to bring the peak of ionization to the tumor site. The specific rate of energy transfer was about 2.5×10^5 ergs/g. per minute and each mouse received treatment of only three or four minutes' duration. Two separate experiments were performed. In each of these, 20 mice were irradiated and 20 tumor-bearing control mice passed through

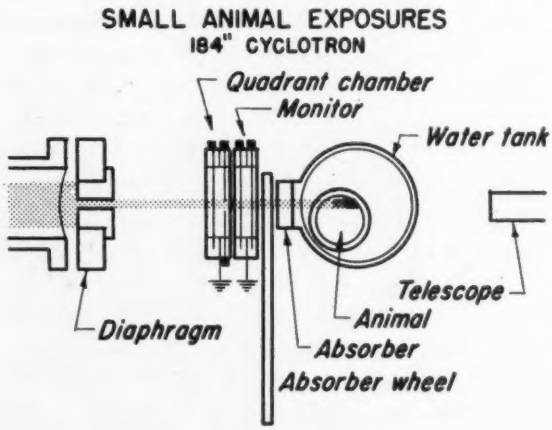

FIG. 15. Method of local irradiation of small animals. The animal is anesthetized and placed in a small lucite cylinder. The cylinder is immersed in a lucite water tank. By rotation and adjustment of the relative positions of the cylinder holding the animal and the water tank, and by adding external absorbers the peak of the Bragg curve can be aligned to any part of the body. During irradiation it is possible to slowly rotate or rock the water tank, thus enhancing the ratio of depth dose to surface dose.

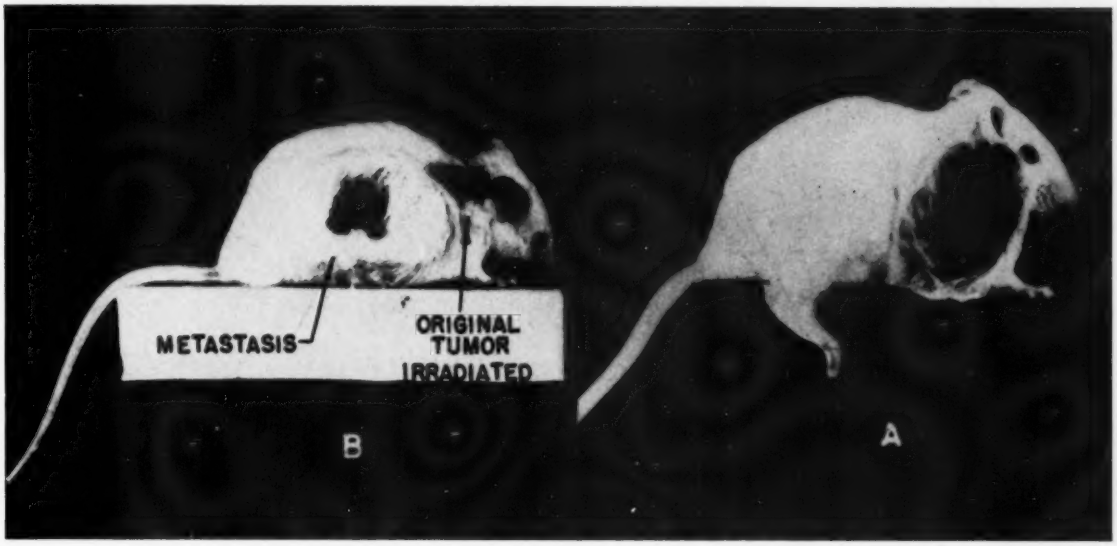

FIG. 16. (*A*) Control mouse, unirradiated, thirty days after transplantation of mammary tumor. (*B*) Tumor mouse treated with deuterons through the body on the tenth day after tumor transplantation. The ray was misdirected and part of the tumor, a direct extension or a metastasis, continued to grow rapidly.

the same handling but received no irradiation. The specific energy transfer was 9×10^5 ergs/g. at the site of the tumor in the first experiment, and 11×10^5 ergs/g. in the second experiment. The beam aperture was adjusted to fit the size of the tumors of the individual mice.

The effect on the irradiated mice (see Table IV) in each instance was quite uniform. Tumor tissues exposed to the most ionizing portions of the beam exhibited rapid regression, in some instances quite complete ten days after irradiation, leaving only scar tissue. At no time thereafter was there any tumor growth observed in any of the mice at or near the central spot of irradiation. A good number of the mice, however, in the treated group still showed continuing tumor growth, resulting apparently from two different causes: (1) The beam was not aligned perfectly in a number of instances and parts of the tumors not affected by the beam continued to grow. (2) There were metastases of the original tumors out of the field of irradiation. In some cases these tumors were along the path of the trocar used for transplanting the tumor, and possibly they represented the deposition of cell fragments at the time of transplantation. Nevertheless, 5 of the first 20 treated animals and 4 of the second group of 20 mice survived the treatment with no ill effects. Altogether 9 animals out of 40 treated survived at least six months after irradiation and their tumors completely regressed.

In Figure 16 a photograph of a typical unirradiated tumor mouse is shown, thirty days after tumor transplantation. Another animal is also shown where the treatment failed since the deuteron beam was misdirected. Figure 17 shows 2 animals twenty days and three months after irradiation. Absence of the tumors is noted; they were replaced by scar tissue. The skin of these animals was epilated and reddened about ten days after radiation treatment. Some of the areas treated became ulcerated, others exhibited hemorrhagic blebs. In cases where no metastases developed, these animals recovered from the skin effects in two or three months. At the end of three months, the skin appeared normal in color, the epidermis somewhat thickened at the site of irradiation, and in most of the animals regrowth of hair occurred.

The irradiated tumor animals lost weight but regained it within a few days after

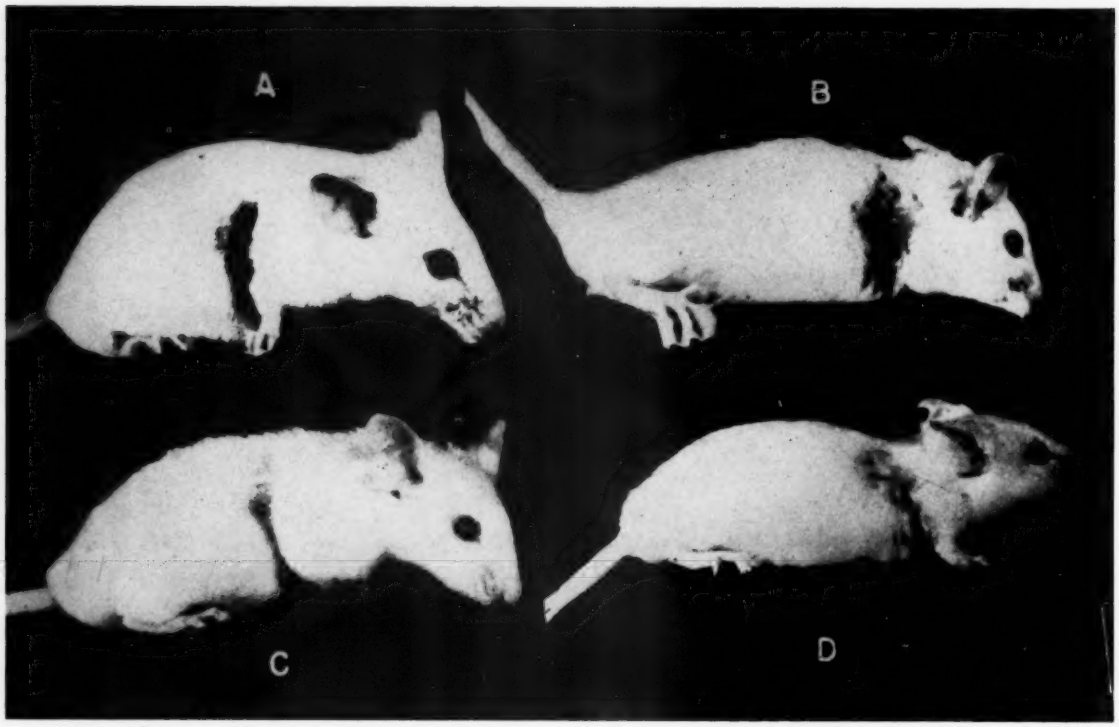

FIG. 17. Tumor mice successfully irradiated with deuterons, the beam passing through their body before reaching the tumor. (*A*) (*B*) Twenty days after irradiation. The tumors are gone, leaving epilated areas and scar tissue. (*C*) (*D*) The same mice three months later. The hair is slowly regrowing over the irradiated areas.

irradiation. In the few animals studied, white and red blood cell counts were temporarily decreased.

Postmortem studies of the animals which died showed in some cases hemorrhage into the lungs; in others, the lungs were partially replaced by fibrous tissue. Other animals apparently died due to unchecked growth of the tumors which had not been accurately irradiated. Some mice in which successful regressions were obtained died as late as nine months after irradiation from late radiation effects without any particular weight loss or previous warning of lethal effect.

Among the group of mice irradiated by the deuterons in Groups II to V of Table IV and where the tumors had regressed, tests were made to determine whether or not the same animals would "take" the same tumor again. It has been reported by many previous workers[33] that mice in which complete tumor regressions were achieved by irradiation become temporarily immune to later transplantation of the same tumor. Twenty-five of the animals that experienced successful regressions were selected and two months after irradiation of the first tumors, retransplants were made. These retransplants did not take in 18 of the 25 animals. These transplants were in an area of the animal body which was entirely unaffected by irradiation. In the other 7 animals the transplants were successful and tumors increased in size rapidly, causing a lethal effect within a few weeks. When retransplantation was attempted in another group of mice after a lapse of four months from the time of irradiation more (60 per cent) of the retransplants were successful. This indicates that the immunity produced was temporary in nature.

Another attempt at irradiation of tumors through the animal body was repeated on

20 white rats with transplanted lymphosarcomas. The percentage results duplicated the data reported for the mice.

DISCUSSION OF THE ANIMAL STUDIES

The ease with which the dosimetry and the exposures for lethal effect were made and the relative facility with which a significant number of highly radioresistant tumors regressed in the mice and rats indicate the advantages of the use of high energy ion beams in certain special problems of experimental radiology and possibly eventually in radiation therapy. The tumor experiments with the mice were carried out with a relatively crude technique, and due to the smallness of the test animal's body, it was unavoidable that a relatively large dose was given to some of the vital organs of the animals. In the case of larger animals or humans, when a relatively small tumor mass is irradiated, the irradiation could be carried out with very little dose to the surrounding vital normal tissues. Since dosimetry can be easily controlled, even if the proper area is not entirely covered in a single irradiation treatment, the radiologist could correct for this by giving a series of small doses to the tumor. However, the preliminary experiments performed here indicate that the use of directed particle beams would be contraindicated if the tumor contours were not accurately known and if the tumor were of a rapidly metastasizing type. In any event it seems clear that the value of intense local radiation treatment also depends on the radiation sensitivity of the normal tissues surrounding the tumor and of the tissues elsewhere in the path of the beam. The availability of ion beams with advantageous depth dose characteristics should stimulate research work in the field of early diagnosis of inoperable tumors and their accurate localization.

CURRENT WORK WITH THE BEAM OF THE 184 INCH CYCLOTRON

The physical and biological tests described above were completed during the middle of 1949. Based on the results achieved, a modest program was initiated on the study of the biological effects of these radiations on small animals and microorganisms. One of the important radiobiological problems that may be studied with the aid of the high energy ion beam is the effects of irradiations on local regions of the animal body. In collaboration with Lieutenant Victor Bond *et al.* of the United States Navy Radiation Laboratory in San Francisco, some data have been secured on the lethal effects produced when a small part of the body volume, approximately 5 per cent, in various locations is irradiated.*

In collaboration with Beukema, Ansley and Reinhardt of the Department of Anatomy of the University of California, some work was done on arresting bone growth in the young white laboratory rat when certain areas of the extremities around the joints are irradiated.[34] This study, as yet unfinished, furnished a dramatic demonstration for the sharp delineation that is possible between irradiated and unirradiated tissues. With the permission of Dr. Reinhardt we reproduce here a histological section of the tibia of a rat (Fig. 18) which was irradiated twenty-six days previously by a beam of deuterons which was passed through a circular aperture 5/8 inch in diameter. The beam was directed to the knee joint of this animal and the boundary of the beam is indicated by dotted lines on the section. The specific energy transfer was 1.85×10^5 erg/g. In the section (linear magnification of 140 ×) the demarcation line of the beam is easily discernible. Near the knee joint the bone marrow is completely depleted of cells and there is no production of new cells. Marked decalcification and other osseous changes are also seen. Beyond the demarcation line the bone marrow and the bone appear to be normal. The sharpness of the dividing line indicates the sharpness of the edge of the beam. This study might possibly

* A report of this work has been submitted for publication.

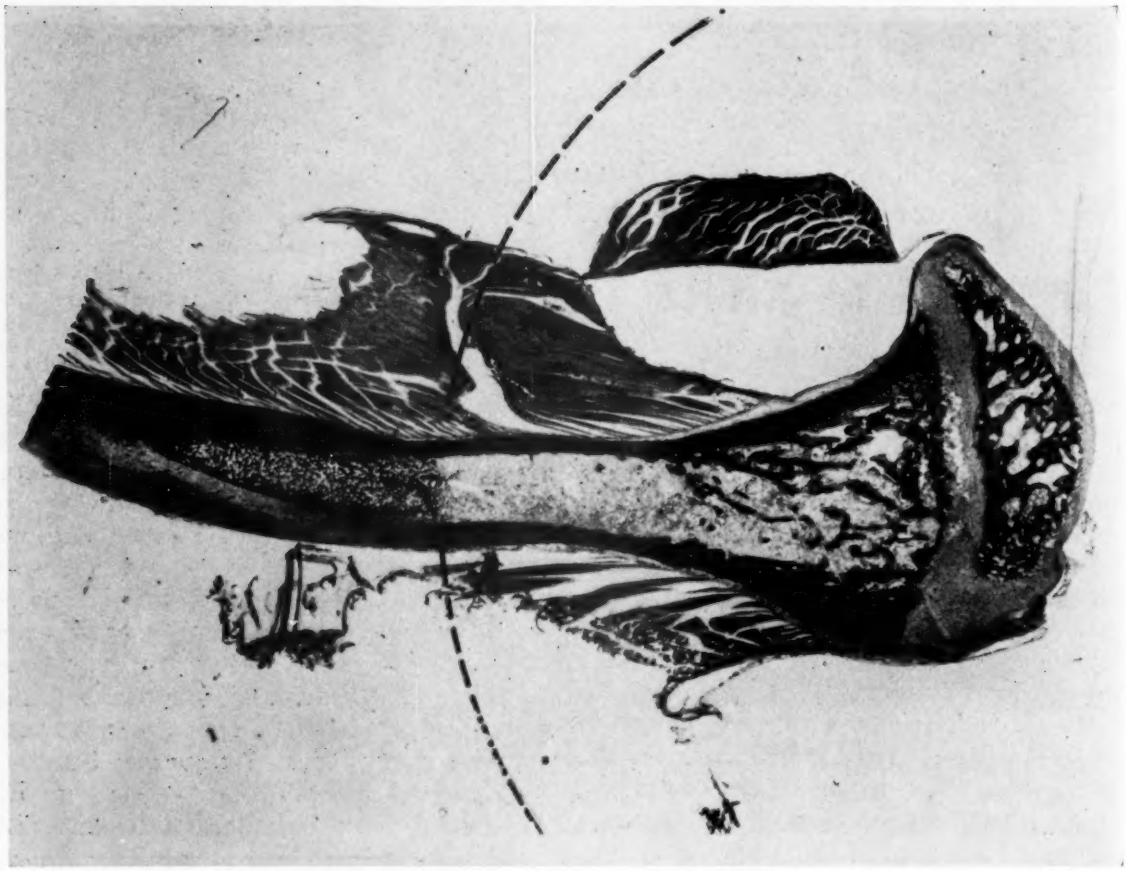

FIG. 18. Histopathological section of rat tibia thirty-six days after irradiation with a radiation field $\frac{5}{8}$ inch in diameter. The boundary of the radiation field is indicated by a dotted line. Note the sharp line of transition between treated and normal marrow. The untreated marrow has normal appearance and is full of cells, while the treated area is aplastic containing many free crenated red blood cells and much fluid. The line of transition is similarly sharp for the osseous changes. This section was prepared by Professor Wm. R. Reinhardt and John R. Beukema.

answer the question as to how much each joint of the animal contributes to the growth of the particular limb. It may possibly give some answers to the question of the regeneration of bone marrow and bone from radiation effects and may be a tool in the study of enhancing healing from radiation damage.

When one irradiates a well defined portion of the body, it is important to have a record of the exact areas irradiated. A convenient method used in this laboratory follows:

A roentgenogram of the animal is taken. Without disturbing the film, the animal and film are transported without changing their respective positions to the position where the cyclotron beam exposure is made. The beam is turned on for a short time and the ions pass through the animal body and the film, resulting in a radiograph of the beam cross section. The beam spot on the film is superimposed on the roentgenogram of the animal, and it indicates the region of the animal body which will be irradiated by the beam. This technique is being currently used in attempts to irradiate selectively the pituitary gland of rats with a 0.3 cm. diameter deuteron beam directed laterally through the head. The purpose of this study is to detect the effect of irradiation of the pituitary gland on the

production of various pituitary hormones. This work is being carried out in collaboration with Donald Van Dyke of the Institute of Experimental Biology and Rex L. Huff of this laboratory.

A set of experiments is being carried out concerning the biological effects of the cyclotron beam on unicellular organisms. Some of these organisms were chosen for the specific properties which are particularly useful in some phases of radiobiological research. The first exposure of single cells was made in collaboration with Norman H. Giles of the Biology Division, Oak Ridge National Laboratory, in which *Tradescantia* pollen was exposed to deuterons and alpha particles of various specific ionizations in order to obtain the relative biological effect as a function of the rate of energy loss for the chromosome breaks produced in these cells.

Particularly promising is the study of the mechanism of the effect of radiation on cell division of yeast cells. This study was initiated with Professor R. E. Zirkle of the University of Chicago during the summer of 1949. An account of further similar investigations was given at the Oberlin Symposium sponsored by the National Research Council.[35] R. L. Dobson of this laboratory has studied the relative biological effect as a function of the rate of energy loss on other microorganisms, notably on the bacterium *E. coli*.[36]

In the present paper the authors have endeavored to show that there are potential applications of this new radiation in the fields of experimental radiotherapy, in the local irradiation of animals for the study of the effect of radiation on various organs, and in radiobiological investigations using unicellular organisms. The studies on unicellular organisms are particularly suitable for demonstration of the mechanism of the biological effects of radiation. Since a number of high energy accelerators are under construction, there should be greater opportunities in the future for utilizing their unique properties for medical and biophysical investigation.

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SUMMARY

The physical properties and isodose curves of 190 mev. deuterons have been described. It is shown that the deuteron beam has unique radiological properties: straight and deep penetration in tissue with small scattering and maximum dose near the end of the range of the beam. The deuteron beam is suitable for effective and intense irradiation of small volumes deep within the body of animals or humans. Detailed accounts of measurements of the ionization, range, stopping power and dosimetry of the ion beam are given. Methods for total and partial body irradiation of small animals are illustrated and results of the acute lethal effects and the effects of local irradiation of mouse tumors are described. Possible application to radiotherapy is pointed out.

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ESTIMATION OF DOSAGE FOR INTRAVENOUSLY ADMINISTERED P^{32}

CALCULATION BASED ON TWO COMPARTMENT DISTRIBUTION OF THE ISOTOPE

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PART I: GENERAL CONSIDERATIONS

EVALUATION of the dose-effect relation when P^{32} is administered internally requires information concerning energy dissipated in the various tissues. Marinelli,[8] Marinelli *et al.*,[10] R. D. Evans,[3] Mayneord,[11] Bush,[1] and others, have developed formulae for calculation of the energy accrued by the tissues due to a single dose of P^{32}.

According to Marinelli the total radiation dose from an amount of P^{32} expressed in microcuries (μc.) in a system where the isotope is uniformly distributed for the time of total radioactive decay is:

$$D\beta = K\beta C \text{ e.r. (equivalent roentgens)} \quad (1)$$

where C = concentration of P^{32} per gram of tissue

$K\beta = 88\overline{E}\beta$ T.e.r. per microcurie destroyed per gm. (μc.δ/gm.)

$\overline{E}\beta = 0.7$ mev. and $T = 14.3$ days

$\therefore$ for $C = 1$ μc./gm.

$$D\beta = 88 \times 0.7 \times 14.3 \times 1 = 880 \text{ e.r.} \quad (2)$$

The accumulated dose for any time interval (t), per microcurie per gram is:

$$\frac{3.7 \times 10^4 \times 1 \times T}{5.24 \times 10^{13} \times 0.693}\left(1 - e^{-0.69\ t/T}\right) \times \overline{E}\beta \text{ e.r.} \quad (3)$$

where $\overline{E}\beta$ is in e.v.

From these equations it follows that:

1.1 μc.δ $P^{32}/kg. \cong 1$ e.r.

1 μc. P^{32}/gm. in 24 hours $\cong$ 43 e.r.

1 μc. P^{32} uniformly distributed in a mass of 70 kg. will deliver 0.6 e.r. to each gram in 24 hours.

Since these calculations assume uniform concentration and retention to complete decay of the administered dose, they apply only to a biologically inert system. Experimental evidence shows, however, that no element which is a physiological metabolite is uniformly distributed in the body. Indeed, distribution is not uniform even throughout a particular organ or tissue.[6] There is no biochemical stability in a biological system. On the contrary, there is a constant flux due to exchange and interchange of the metabolite among various tissues, as well as a daily loss due to excretion. These considerations apply particularly to phosphorus which is the most ubiquitous cell metabolite.

There is no method known at present by which biological flux can be measured. A determination of the concentration in an aggregate of tissue at any given time is possible, however. The rate of clearance from blood and excretion in the urine and stool of a radioisotope can, of course, be measured. From the amount lost by excretion the total amount remaining in the body at any given time can be calculated.

An adequate basis for estimating the general distribution of radiophosphorus in various body tissues is found in the data resulting from animal experiments, and autopsy and biopsy studies of human subjects.[2,4,5,6,7,9,12,13] Different species and individuals within the same species show marked variations in tissue distribution of radiophosphorus. In general, bone shows the greatest avidity for this metabolite, and is followed in order by spleen, liver, kidney, muscle, blood, fat, skin and nerve tissue. Within six to twenty-four hours after administration of single and multiple test doses of 4 to 9 μc. per kg. of P^{32} in the

form of Na_2HPO_4, the concentration in bone is four to six times greater than in muscle, fat or skin. After seventy-two hours, the concentration in bone is six to ten times greater than that in muscle, fat or skin. Concentrations in bone, spleen and liver may differ from one another at certain intervals, but the uptake in these tissues is of the same order of magnitude and is as much as six to ten times as great as in all other tissues. Bone, spleen and liver, in which the greatest differential concentration of radiophosphorus occurs, together constitute approximately 10 to 12 per cent of total body weight. Bone, spleen and liver are all involved in hematopoiesis.

These observations indicate a need for a method of estimating dosage from P^{32} which recognizes the existence of two main compartments with respect to concentration of radiophosphorus. One compartment should include bone, spleen and liver, and the other compartment all other tissues. It would be incorrect to suppose that two compartment distribution of radiophosphorus represents a rigid relationship which is established immediately after administration of the radioisotope. On the contrary, distribution is virtually uniform for a brief period after administration. This is followed by a period of rapid interchange and high excretion lasting about three days. This may be regarded as the "equilibration period." After "equilibrium" is reached, the two compartment distribution may be considered as established, and the rate of excretion becomes practically constant.

From the point of view of calculation of dosage only that amount of the administered dose of a radioisotope is important which undergoes disintegration within the body. This is proportional to the total retained fraction of the administered amount. The amount retained in the body is equal to the amount administered less the amount excreted.

The relationship between the amount retained in the tissues and the dose of radiation delivered is evident. The determination of the excretion rate in an individual patient, though possible, is impractical as an everyday clinical procedure. Low-Beer, Lawrence and Stone[6] developed a method for estimating the amount of radioactive phosphorus retained in the body. Table 1 gives the retained dose values expressed as percentages of the administered dose for the first three days and, following the third day, as percentages of the amount retained on the third day. These values represent averages based upon experimental determinations of excretion rates in healthy individuals and patients following the intravenous administration of single and multiple doses of P^{32} in the form of Na_2HPO_4 containing 5 to 15 mg.

TABLE I

CALCULATION OF RETAINED ACTIVITY

For the first three days the activity on each day is calculated as a per cent of the administered dose

Days	Per Cent Administered Dose
1	90
2	83
3	77

For each day after the third day the activity is calculated as a per cent of the activity retained on the third day

Days	Per Cent of Third Day Activity	Days	Per Cent of Third Day Activity
4	94	19	37
5	88	20	35
6	83	21	33
7	78	22	31
8	74	23	29
9	69	24	27
10	65	25	26
11	61	26	24
12	58	27	23
13	54	28	21
14	50	29	20
15	48	30	19
16	45	31	18
17	42	32	17
18	40	33	15

phosphate carrier per cubic centimeter. These values have been used in the following calculations. The inaccuracy involved in using them is well within the range of exactitude of clinical dosimetry.

Following determination of the retained amount of P^{32}, it is assumed that by the third day a 10:1 ratio is established between the bone-spleen-liver compartment, on the one hand, and the muscle-skin-fat compartment, on the other. For the sake of simplicity the first compartment is referred to in the calculations as "bone" compartment and the second as "soft tissue" compartment. The bone compartment is assumed to be 10 per cent of the body weight. These assumptions may be subject to certain criticisms. The 10:1 ratio between the two compartments actually represents the maximum rather than the average ratio between them. It has been considered preferable, however, to use a maximum rather than an average figure in order to insure a safer approach to treatment. The method of therapy with P^{32} is, in most instances, a fractionation method whereby the total dose is built up gradually; therefore, the assumption of a lower ratio might easily produce a too high "bone compartment" dose, resulting in adverse hematological effects. The assumption of a 10:1 ratio on the third day may be questioned also, as the ratio is reached only gradually over a longer period of time. While this is true, the error involved is negligible. On the other hand, this method of estimating dos-

NAME _____ COMPARTMENT | Mega-gm-r | gm-r/gm
AGE ____ WT: 50 Kg SOFT TISSUE
BONE

P^{32} I.V.			SOFT TISSUE DOSE IN gm-r/gm		BONE DOSE IN gm-r/gm		DOSAGE RATE IN gm-r/gm/mc/day		
DATE	mc P^{32}	DR.	DAILY	CUMULATIVE	DAILY	CUMULATIVE	DAY	SOFT TISSUE	BONE
							0	0.83	0.83
							1	0.64	1.70
							2	0.48	2.53
							3	0.33	3.38
							4	0.31	3.18
							5	0.29	2.98
							6	0.27	2.82
							7	0.26	2.66
							8	0.24	2.51
							9	0.23	2.35
							10	0.22	2.20
							11	0.20	2.08
							12	0.19	1.95
							13	0.18	1.83
							14	0.17	1.71
							15	0.16	1.59
							16	0.15	1.50
							17	0.14	1.41
							18	0.13	1.32
							19	0.12	1.23
							20	0.11	1.15
							21	0.11	1.08
							22	0.10	1.01
							23	0.09	0.94
							24	0.09	0.87
							25	0.08	0.80
							26	0.08	0.76
							27	0.07	0.72
							28	0.07	0.69
							29	0.06	0.65
							30	0.06	0.62
							31	0.06	0.58
							32	0.06	0.55
							33	0.05	0.51
							34	0.05	0.48
							35	0.05	0.45
							36	0.05	0.42
							37	0.05	0.40
							38	0.04	0.37
							39	0.04	0.35
							40	0.04	0.33
							41	0.04	0.31
							42	0.04	0.29
							43	0.03	0.27
							44	0.03	0.26
							45	0.03	0.24
							46	0.03	0.22
							47	0.03	0.21
							48	0.03	0.20

FIG. 1. Dose Record I for patients weighing from 90 to 126 lb. The patient's name, age and true weight correction factor from Table III are entered at the top of the Record Form.

NAME _____ COMPARTMENT | Mega-gm-r | gm-r/gm
AGE ____ WT 60 Kg SOFT TISSUE
BONE

P^{32} I.V.			SOFT TISSUE DOSE IN gm-r/gm		BONE DOSE IN gm-r/gm		DOSAGE RATE IN gm-r/gm/mc/day		
DATE	mc P^{32}	DR.	DAILY	CUMULATIVE	DAILY	CUMULATIVE	DAY	SOFT TISSUE	BONE
							0	0.69	0.69
							1	0.54	1.40
							2	0.40	2.10
							3	0.28	2.82
							4	0.26	2.65
							5	0.24	2.48
							6	0.23	2.35
							7	0.22	2.22
							8	0.20	2.10
							9	0.19	1.96
							10	0.18	1.83
							11	0.17	1.73
							12	0.16	1.63
							13	0.16	1.52
							14	0.15	1.42
							15	0.14	1.32
							16	0.13	1.24
							17	0.12	1.17
							18	0.11	1.10
							19	0.10	1.03
							20	0.10	0.96
							21	0.09	0.91
							22	0.08	0.86
							23	0.08	0.81
							24	0.07	0.76
							25	0.07	0.71
							26	0.06	0.67
							27	0.06	0.63
							28	0.06	0.59
							29	0.06	0.55
							30	0.06	0.51
							31	0.05	0.48
							32	0.05	0.45
							33	0.05	0.42
							34	0.05	0.40
							35	0.04	0.37
							36	0.04	0.35
							37	0.04	0.33
							38	0.04	0.31
							39	0.03	0.29
							40	0.03	0.27
							41	0.03	0.25
							42	0.03	0.24
							43	0.03	0.22
							44	0.02	0.21
							45	0.02	0.20
							46	0.02	0.19
							47	0.02	0.18
							48	0.02	0.16

FIG. 2. Dose Record II for patients weighing from 127 to 146 lb. The patient's name, age and true weight and the weight correction factor from Table III are entered at the top of the Record Form.

age in clinical practice by taking into account the factors which characterize an active biological system has certain advantages over calculations based on uniform distribution and complete retention of any administered amount of radiophosphorus because (a) it gives a better indication of accrued energy within the tissues; (b) it affords a better correlation of the physical dose with the biological effect; (c) it provides greater insurance against excessive irradiation; (d) it affords a sounder basis for the comparison of radiation doses from roentgen rays and radioisotopes.

Ambiguity in the usage of the term "dose" is often encountered in radiological literature. It is used both to describe the amount of radioactivity introduced into tissues and to state the energy dissipated in the tissues. Strictly, however, from the point of view of biological effect, only the radiation dose, that is the energy dissipated, is significant and therefore the correct usage should be restricted to this meaning.

While in the foregoing, dosage was expressed in "equivalent roentgens" (e.r.), in the following calculations the energy accrued is expressed in gram-roentgens per gram. The gram-roentgen is a unit introduced by Mayneord. By definition 1 gram-roentgen is the absorption of 83.8 ergs in an unspecified amount of air from any ion izing radiations. The gram-roentgen is a unit of integral dose and when it is used with reference to a unit mass of tissue it

NAME _____ COMPARTMENT | Mega-gm-r | gm-r/gm
AGE ___ WT: 70Kg SOFT TISSUE
BONE

P^{32} I.V.			SOFT TISSUE DOSE IN gm-r/gm		BONE DOSE IN gm-r/gm		DOSAGE RATE IN gm-r/gm/mc/day		
DATE	mc P^{32}	DR	DAILY	CUMULATIVE	DAILY	CUMULATIVE	DAY	SOFT TISSUE	BONE
							0	0.59	0.59
							1	0.46	1.21
							2	0.35	1.81
							3	0.24	2.41
							4	0.22	2.17
							5	0.21	2.12
							6	0.20	2.01
							7	0.19	1.90
							8	0.18	1.79
							9	0.17	1.68
							10	0.16	1.57
							11	0.15	1.49
							12	0.14	1.40
							13	0.13	1.31
							14	0.12	1.22
							15	0.11	1.14
							16	0.11	1.07
							17	0.10	1.00
							18	0.10	0.94
							19	0.09	0.88
							20	0.08	0.82
							21	0.08	0.77
							22	0.07	0.73
							23	0.07	0.68
							24	0.06	0.64
							25	0.06	0.60
							26	0.06	0.56
							27	0.05	0.53
							28	0.05	0.50
							29	0.04	0.46
							30	0.04	0.44
							31	0.04	0.42
							32	0.04	0.39
							33	0.03	0.37
							34	0.03	0.34
							35	0.03	0.32
							36	0.03	0.30
							37	0.03	0.28
							38	0.02	0.27
							39	0.02	0.25
							40	0.02	0.24
							41	0.02	0.22
							42	0.02	0.21
							43	0.02	0.20
							44	0.02	0.18
							45	0.02	0.17
							46	0.01	0.16
							47	0.01	0.15
							48	0.01	0.14

Fig. 3. Dose Record III for patients weighing from 147 to 165 lb. The patient's name, age and true weight and the weight correction factor from Table III are entered at the top of the Record Form.

NAME _____ COMPARTMENT | Mega-gm-r | gm-r/gm
AGE ___ WT: 80Kg SOFT TISSUE
BONE

P^{32} I.V.			SOFT TISSUE DOSE IN gm-r/gm		BONE DOSE IN gm-r/gm		DOSAGE RATE IN gm-r/gm/mc/day		
DATE	mc P^{32}	DR	DAILY	CUMULATIVE	DAILY	CUMULATIVE	DAY	SOFT TISSUE	BONE
							0	0.52	0.52
							1	0.40	1.06
							2	0.30	1.58
							3	0.21	2.11
							4	0.20	1.99
							5	0.18	1.86
							6	0.17	1.76
							7	0.16	1.66
							8	0.16	1.57
							9	0.15	1.47
							10	0.14	1.37
							11	0.14	1.30
							12	0.13	1.22
							13	0.12	1.14
							14	0.11	1.07
							15	0.10	0.99
							16	0.10	0.94
							17	0.09	0.88
							18	0.08	0.83
							19	0.07	0.77
							20	0.07	0.72
							21	0.06	0.68
							22	0.06	0.64
							23	0.06	0.60
							24	0.05	0.57
							25	0.05	0.53
							26	0.05	0.50
							27	0.05	0.47
							28	0.04	0.44
							29	0.04	0.41
							30	0.04	0.38
							31	0.04	0.36
							32	0.03	0.34
							33	0.03	0.32
							34	0.03	0.30
							35	0.03	0.28
							36	0.02	0.26
							37	0.02	0.25
							38	0.02	0.23
							39	0.02	0.22
							40	0.02	0.20
							41	0.02	0.19
							42	0.02	0.18
							43	0.02	0.17
							44	0.01	0.16
							45	0.01	0.15
							46	0.01	0.14
							47	0.01	0.13
							48	0.01	0.12

Fig. 4. Dose Record IV for patients weighing from 166 to 176 lb. The patient's name, age and true weight and the weight correction factor from Table III are entered at the top of the Record Form.

must be written gram-roentgen per gram of tissue (gm-r/gram). Although 1 gm-r /gram = 1 e.r. = 1 rep, this term is used in preference to equivalent roentgen (e.r.) or to roentgen equivalent physical (rep) as a constant reminder of the importance of the weight of the patient in such dose calculations.

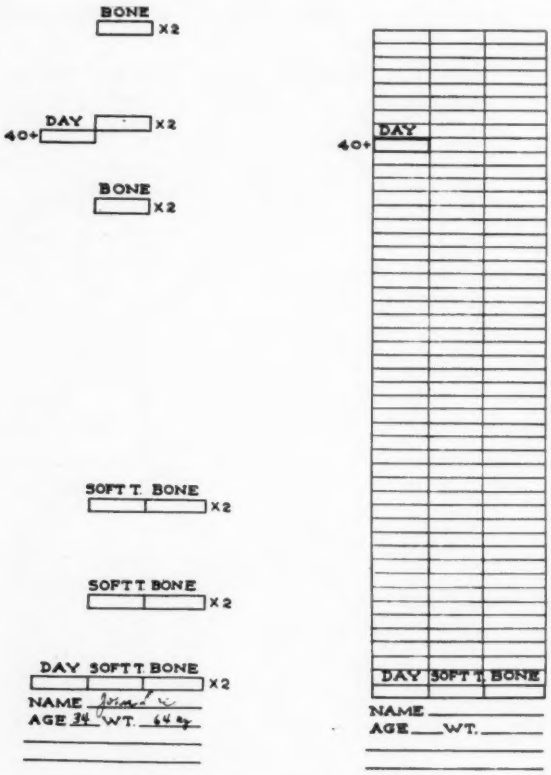

FIG. 5. Treatment plan overlay strip. This strip is made of a thin transparent material such as celluloid and is used in connection with the last three columns of the Dose Record forms to compute the daily dose in gm-r/gm. The overlay strip is shown on the right before, and, on the left, after the treatment plan has been prepared. The grid lines have been left out for greater clarity on the left hand strip.

The calculations presented in the Part III of this paper show that approximately 76 per cent of the P^{32} present on the third day decays in the body. This is 58.4 per cent of the administered dose and, when added to the 12.2 per cent which decays in the body in the first three days, gives a total of 70.6 per cent of the administered dose decaying in the body. By calculation 34.4 per cent of the administered dose decays in "bone" and 35.6 per cent decays in "soft tissue." Since bone comprises approximately 10 per cent of the body weight, the above percentages indicate a concentration ratio and therefore a dose ratio of 34.4/10: 35.6/90 or approximately 9:1.

PART II: CHARTING OF TREATMENT AND THE USE OF DOSE RECORD FORMS

In order to facilitate the practical use of the principles of dose calculation by com-

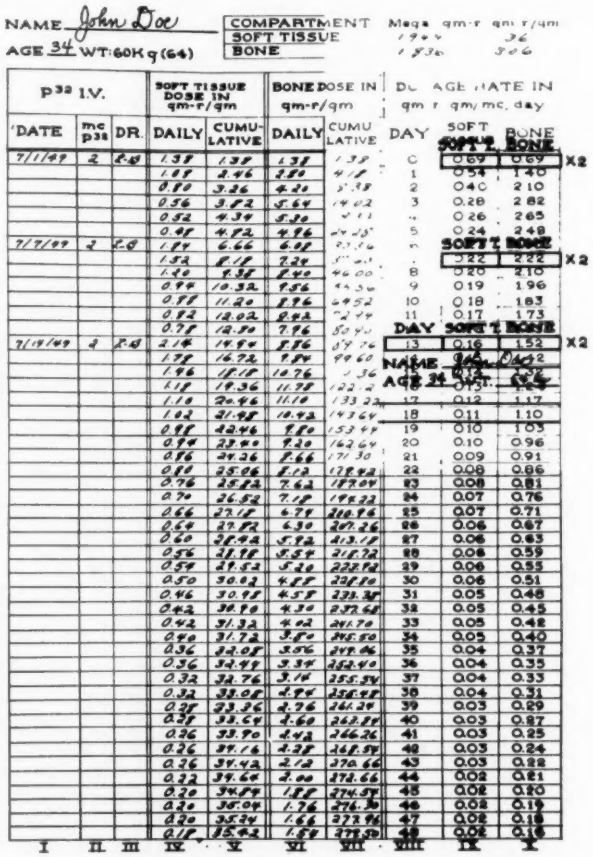

FIG. 6. Dose Record Form and overlay strip. The treatment plan outlined on the left hand strip in Figure 5 has been used to fill in the Dose Record form. The overlay is shown being used to determine the dose delivered on the 13th day of treatment. The expected dosage rate and total integral dose for each compartment have been found from Figures 11 and 12 and are entered in the upper right hand corner.

TABLE II

90–126 lb.—40–56 kg., record I
127–146 lb.—57–66 kg., record II
147–165 lb.—67–75 kg., record III
166–176 lb.—76–86 kg., record IV

partments, dose record forms have been devised. Four different record forms have been made covering patients in the weight range between 40 and 90 kg. (Fig. 1–4). Patients within the following weight ranges should be assigned to the proper record form (Table II).

Table III (A, B, C, D,) gives the weight correction factors to the patient's true weight:

TABLE III

WEIGHT CORRECTION FACTORS

Chart A			Chart C		
Weight		Correction	Weight		Correction
Kg.	Lb.	Factor	Kg.	Lb.	Factor
40	88	1.25	67	148	1.05
41	90	1.22	68	150	1.03
42	93	1.19	69	152	1.01
43	95	1.16	70	154	1.00
44	97	1.15	71	157	.99
45	99	1.11	72	159	.97
46	101	1.09	73	161	.96
47	104	1.06	74	163	.95
48	106	1.04	75	165	.93
49	108	1.02			
50	110	1.00			
51	112	.98			
52	115	.96			
53	117	.94			
54	119	.93			
55	121	.91			
56	123	.89			
Chart B			Chart D		
57	126	1.05	76	168	1.05
58	128	1.03	77	170	1.04
59	130	1.02	78	172	1.02
60	132	1.00	79	174	1.01
61	134	.98	80	176	1.00
62	137	.97	81	179	.99
63	139	.95	82	181	.98
64	141	.94	83	183	.97
65	143	.92	84	185	.95
66	146	.91	85	187	.94
			86	190	.93

Figure 6 is a sample treatment record. At the bottom of the record Roman numerals are used to mark the columns in order to show the explanation more easily. Patient J. D., aged thirty-four, weighing 64 kg., received a total of 6 millicuries of P^{32} in fractions of 2 mc. each. Between the first and second treatment there was an interval of six days. Between the second and third treatment the interval was seven days. Columns I, II, and III form the P^{32} administration record, providing space for date, number of millicuries of P^{32} administered and physician's initials. Columns IV and V provide for the recording of the daily dose and cumulative dose in gram-roentgens per gram in soft tissue. Columns VI and VII provide for the same record in gram-roentgens per gram in bone. Columns VIII, IX and X provide the information necessary to fill in Columns IV–VII, namely the daily dose delivered each day, after administration of 1 mc. of P^{32}, to each gram of soft tissue and to each gram of bone.

For each chart a treatment plan overlay strip may be prepared (Fig. 5). The treatment plan is indicated by outlining the dosage rate rectangle opposite the day desired and placing the number of millicuries administered that day to the right as an indicated multiplying factor.

The method of use of these charts and overlay strip may best be explained by means of an example (see Fig. 5 and 6):

Problem: Patient is to be given 6,000 μc. of P^{32} intravenously in three administrations of *2,000* μc. each. The second administration to follow the first on the *sixth* day while the third administration is to be given on the *thirteenth* day. Patient's weight is 64 kg. (141 lb.)

(1) From Table II it is seen that record II should be used for a 64 kg. man.

(2) Place the overlay on the chart so that the rectangle marked "day" (found in the lower left corner) encloses "0" of the day column on the chart (Column VIII).

(3) To the right, the two rectangles marked Soft T. and Bone will be seen to enclose .69 and .69.

(4) To the right of the bone rectangle on the overlay mark the multiplying factor on the line

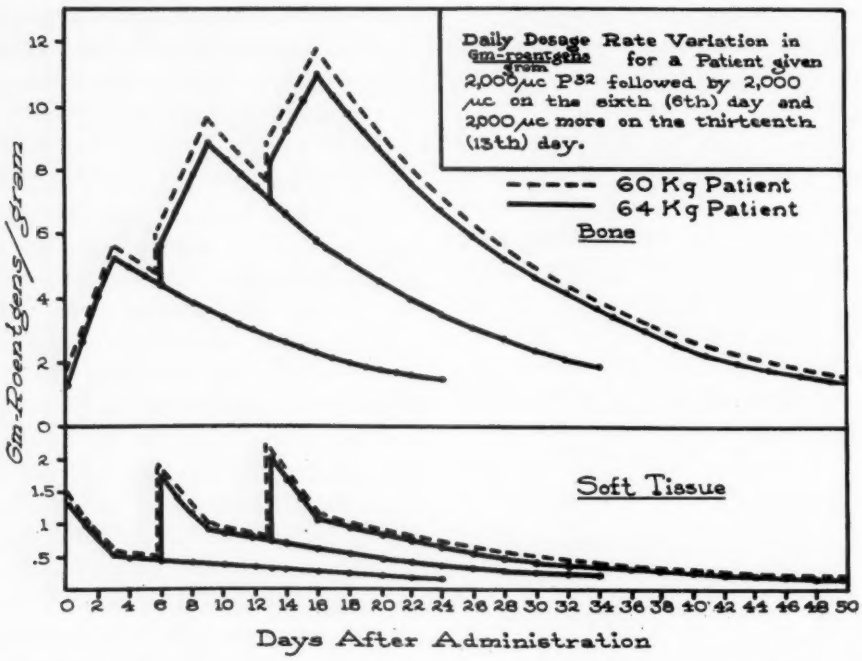
Daily Dosage Rate Variation in gm-roentgens from for a Patient given 2,000 μc P32 followed by 2,000 μc on the sixth (6th) day and 2000 μc more on the thirteenth (13th) day.
60 Kg Patient
64 Kg Patient
Bone
Soft Tissue
Gm-Roentgens/Gram
Days After Administration

FIG. 7. The Daily Dosage Rate in gm-r/gm. received by the patient whose overlay strip and Dose Record Form have been shown in Figures 5 and 6. The solid line represents dosages calculated without, and the dashed line dosages calculated with weight correction factors.

NAME C.C.C.
AGE 62 WT 80 Kg (83)

COMPARTMENT	Mega-gm-r	gm-r/gm
SOFT TISSUE	2.27	50
BONE	2.14	25.5

	P32 I.V.			SOFT TISSUE DOSE IN gm-r/gm		BONE DOSE IN gm-r/gm		DOSAGE RATE IN gm-r/gm/mc/day		
	DATE	mc P32	DR	DAILY	CUMULATIVE	DAILY	CUMULATIVE	DAY	SOFT TISSUE	BONE
	8/23/50	3.5	C-B	1.75	1.75	1.75	1.75	0	0.52	0.52
	8/24/50	3.5	C-B	3.10	4.85	5.32	7.07	1	0.40	1.06
	25			2.36	7.21	8.89	15.96	2	0.30	1.58
	26			1.72	8.93	12.42	28.38	3	0.21	2.11
	27			1.38	10.31	13.80	42.18	4	0.20	1.99
	28			1.28	11.58	12.96	55.14	5	0.18	1.86
	29			1.18	12.77	12.19	67.33	6	0.17	1.76
X	30			1.11	13.88	11.51	78.84	7	0.16	1.66
	31			1.08	14.96	10.87	89.71	8	0.16	1.57
	9/1/50			1.04	16.00	10.24	99.95	9	0.15	1.47
	2			.97	16.97	9.56	109.51	10	0.14	1.37
	3			.94	17.91	8.99	118.50	11	0.14	1.30
	4			.91	18.82	8.48	126.99	12	0.13	1.22
	5			.84	19.66	7.95	134.94	13	0.12	1.14
X	6			.77	20.43	7.44	142.38	14	0.11	1.07
	7			.71	21.14	6.84	149.22	15	0.10	0.99
	8			.68	21.82	6.50	155.72	16	0.10	0.94
	9			.64	22.46	6.12	161.84	17	0.09	0.88
	10			.57	23.03	5.76	167.60	18	0.08	0.83
	11			.50	23.53	5.40	173.00	19	0.07	0.77
	12			.46	23.99	5.03	178.03	20	0.07	0.72
X	13			.43	24.42	4.72	182.75	21	0.06	0.68
	14			.40	24.82	4.45	187.20	22	0.06	0.64
	15			.40	25.22	4.18	191.38	23	0.06	0.60
	16			.37	25.59	3.94	195.32	24	0.05	0.57
	17			.34	25.93	3.70	199.02	25	0.05	0.53
	18			.34	26.27	3.46	202.48	26	0.05	0.50
	19			.34	26.61	3.26	205.74	27	0.05	0.47
X	20			.30	26.91	3.06	208.80	28	0.04	0.44
	21			.26	27.17	2.86	211.66	29	0.04	0.41
	22			.26	27.43	2.66	214.32	30	0.04	0.38
	23			.26	27.69	2.49	216.81	31	0.04	0.36
	24			.23	27.92	2.36	219.17	32	0.03	0.34
	25			.20	28.12	2.23	221.40	33	0.03	0.32
	26			.20	28.32	2.09	223.49	34	0.03	0.30
	27			.20	28.52	1.95	225.44	35	0.03	0.28
	28			.17	28.69	1.82	227.26	36	0.02	0.26
	29			.16	28.85	1.72	228.98	37	0.02	0.25
	30			.14	28.97	1.61	230.59	38	0.02	0.23
	10/1/50			.14	29.11	1.51	232.10	39	0.02	0.22
	2			.14	29.25	1.41	233.51	40	0.02	0.20
	3			.14	29.39	1.31	234.82	41	0.02	0.19
X	4			.14	29.53	1.25	236.07	42	0.02	0.18
	5			.14	29.67	1.18	237.25	43	0.02	0.17
	6			.10	29.77	1.11	238.36	44	0.01	0.16
	7			.06	29.83	1.05	239.41	45	0.01	0.15
	8			.06	29.89	.98	240.39	46	0.01	0.14
	9			.06	29.95	.91	241.30	47	0.01	0.13
	10			.06	30.01	.84	242.14	48	0.01	0.12

FIG. 8. The completed Dose Record Form for a patient given 7 mc. P^{32} in two 3.5 mc. administrations one day apart. The crosses on the left hand margin indicate dates on which a blood count was taken.

"Day 0." The multiplying factor is found by multiplying the number of millicuries administered that day times the correction factor from Table III. In this case the multiplying factor will be 2× the correction factor of 0.938 or 1.875.

(5) Slide the overlay down until the "Day" rectangle encloses "6."

(6) To the right the two rectangles marked Soft T. and Bone will be seen to enclose .23 and 2.35 respectively.

(7) Repeat (4).

(8) Slide the overlay down until the "Day" rectangle encloses "13."

(9) To the right the two rectangles marked Soft T. and Bone will be seen to enclose .16 and 1.52 respectively.

(10) Repeat (4).

Use of overlay.

The daily dose is computed by placing the

Day rectangle on the desired day in Column VIII and adding the products of the multiplying factors (mc. administered×the weight correction factor) and the daily dose per millicurie administered for each compartment.

Example: What is the daily dose for soft tissue and bone on the 29th day?

Procedure.

(1) Set the overlay Day rectangle over 29. *For Soft Tissue:* The first product taken from be obtained from Figure 12 using the Final Total Dose delivered which is given in Figure 11.

Example: What is the cumulative dose on the 11th day for soft tissue and bone?

From Figure 11 the total dose for a patient of 60 kg. given 2 mc. P^{32} is 102 gm-r/gm. for bone and 12 gm-r/gm. for soft tissue. The 11th day cumulative dose from the first 2 mc. (from Fig. 12) is 54 per cent for soft tissue and 45.5 per cent for bone.

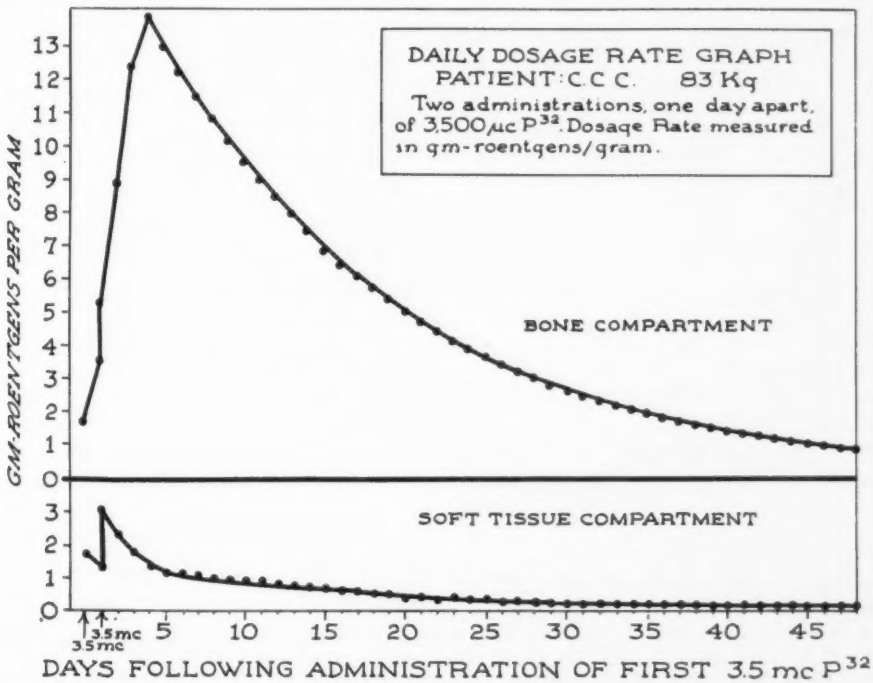
DAILY DOSAGE RATE GRAPH
PATIENT: C.C.C. 83 Kg
Two administrations, one day apart, of 3,500 μc P^{32}. Dosage Rate measured in gm-roentgens/gram.
GM-ROENTGENS PER GRAM
BONE COMPARTMENT
SOFT TISSUE COMPARTMENT
3.5mc
3.5mc
DAYS FOLLOWING ADMINISTRATION OF FIRST 3.5 mc P^{32}

Fig. 9. The Daily Dosage Rate variation for the patient whose Dose Record Form is shown in Figure 8. The weight correction factor was used in computing the dose received.

the soft tissue rectangle in Column IX is 1.875 ×0.06, the second is 1.875×0.08 and the third is 1.875×0.13. The sum of these products is entered in Column IV for Day 29. In the example chart shown in Figure 6 the weight correction factors have been left out so that the above products are 2×0.06, 2×0.08, and 2×0.13. The sum of these products then equals 0.54 and is entered in Column IV for Day 29 as above.

For Bone: The above procedure is followed taking the figures from the Bone rectangles (Column X). These give 2×0.55+2×0.81 +2×1.24=5.20 which is entered in Column VI for day 29.

The Cumulative Dose may be easily obtained by adding up all previous daily doses, or it may

The corresponding percentages for the 5th day are 35 per cent and 23 per cent. The 11th day cumulative doses are then:

Soft tissue: (0.54+0.35) 12 gm-r/gm.=10.7 gm-r/gm.

Bone: (0.455+0.23) 102 gm-r/gm.=69.8 gm-r/gm.

Similarly, cumulative values for the 48th day are:

Soft tissue: (0.955+0.935+0.90)12=33.5 gm-r/gm.

Bone: (0.945+0.920+0.880)102=280 gm-r/gm.

By the 48th day (from Fig. 12) the patient has received

91 per cent of Bone final dose, and

99 per cent of Soft Tissue final dose.*

If it is desired to continue charting beyond the 48th day it is possible to extend the range of the chart by use of the upper part of the overlay. When the Day rectangle is placed on 48 it will be noted that the "Day+40" rectangle (in the upper left corner) is on 8.

One of the *soft tissue* values around the 12th day usually corresponds to the *bone* value of the 48th day. This rectangle is outlined on the overlay, the multiplying factor is placed beside it, and the whole procedure of laying out the treatment plan is repeated. This will give the bone dose only, after the 48th day, the soft tissue dose being considered negligible.

If a number of cumulative doses are to be calculated it is simpler to use an adding machine, subtotaling after each daily dose. The daily cumulative dose figures will then all be marked by the "S" and may be copied off the tape.

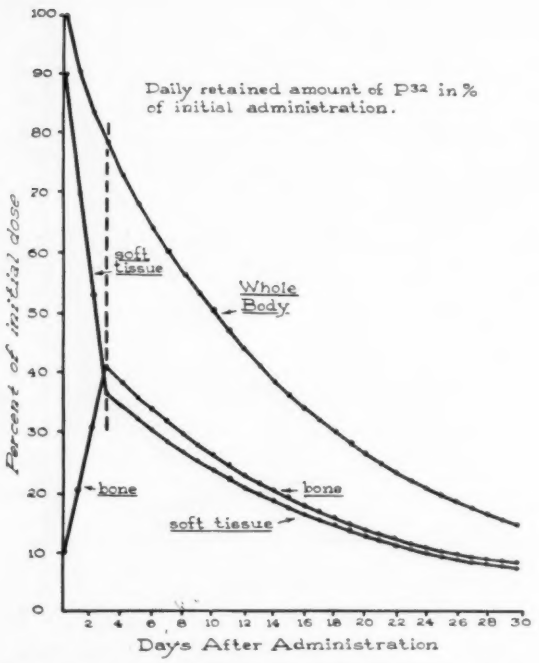

FIG. 10. The retained amount of P^{32} expressed as a percentage of the administered amount at any time expressed in days after administration. The whole body retention curve was plotted from experimental data. The bone retention was assumed to increase linearly for the first three days and then to follow an exponential decay path. The soft tissue retention was then derived from the differences between the whole body retention values and the bone retention values for each day.

* This difference in per cent cumulative dose delivered within the same time may perhaps be explained by the initial differences in concentration of the isotope.

PART III: CALCULATION OF DAILY RETAINED AMOUNTS OF P^{32}

The calculation of dose retention was divided between the first three days and following the third day. The whole body retention curve (Fig. 10) was plotted from experimental data.[6] The bone accumulation for the first three days was assumed to increase linearly. The soft tissue retention then was derived from the differences between the total body retention values and the bone accumulation values for each day.

When the total amount of P^{32} in a compartment of the body is A μc. and the total mass of that compartment is M grams, then the concentration of P^{32} in that compartment is:

$$C=\frac{A}{M}\ \mu\text{c./gm.} \qquad (1)$$

Designating the "bone" compartment by the subscript B and the "soft tissue" compartment by the subscript T the assumption of an *initially* uniform distribution will be:

$$C_B=C_T=Co. \qquad (2)$$

Where Co is the initial concentration in any part or tissue of the body, and

$$A_B+A_T=Ao \text{ (the administered dose)}$$

and from (1)

$$\begin{aligned} A_B&=CoM_B \\ A_T&=CoM_T. \end{aligned} \qquad (3)$$

When A_B and A_T are expressed as percentages of the total amount (A_B+A_T) then,

$$\%A_B=\frac{A_B\times 100}{A_B+A_T}, \qquad \%A_T=\frac{A_T\times 100}{A_B+A_T},$$

or using (3):

$$\%A_B=\frac{A_B\times 100}{A_B+A_T}=\frac{CoM_B\times 100}{CoM_B+CoM_T}$$

$$=\frac{M_B\times 100}{M_B+M_T}=\%M_B=10\%^*, \quad (4)$$

$$\%A_T=\frac{A_T\times 100}{A_B+A_T}=\frac{CoM_T\times 100}{CoM_B+CoM_T},$$

$$=\frac{M_T\times 100}{M_B+M_T}=\%M_T=90\%, \quad (5)$$

then it follows from (2) that,

$$A_B=0.1Ao \quad (6)$$

$$A_T=0.9Ao. \quad (7)$$

On the third day, however,

$$C_B=10C_T \text{ and } A_B+A_T=.77Ao \quad (8)$$

and note also that

$$M_T+M_B=10M_B \text{ and } M_T=9M_B. \quad (9)$$

Again, from (1),

$$A_B=C_BM_B$$

and

$$A_T=C_TM_T \quad (10)$$

expressed as percentage of Ao,

$$\%A_B=\frac{A_B\times 100}{Ao}=\frac{C_BM_B\times 100}{Ao}$$

$$=\frac{10C_T\mathrm{M}_B\times 100}{(A_B+A_T)/.77} \text{ from (8) and (9)}$$

$$\%A_B=\frac{10C_TM_B\times 77}{10C_TM_B+C_TM_T}=\frac{10\times 77M_B}{10M_B+9M_B}$$

$$=\frac{77\times 10}{19}=40.5\% \quad (11)$$

similarly,

$$\%A_T=\frac{A_T\times 100}{Ao}=\frac{C_TM_T\times 100\times 0.77}{A_B+A_T}$$

$$=\frac{C_TM_T\times 77}{C_BM_B+C_TM_T}$$

$$\%A_T=\frac{C_TM_T\times 77}{10C_T\times M_T/9+C_TM_T},$$

$$=\frac{77}{(10+9)/9}=\frac{77\times 9}{19}=36.5\%. \quad (12)$$

After the third day the retention values follow an exponential decay curve, e.g., if KAo is the amount present on the third day in one compartment then the amount present t days later will be:

$$A_t=KAoe^{-\lambda Et} \quad (13)$$

where λE is the effective decay constant.

As developed above in (8), (11) and (12),

$K_{WB}Ao$ (for whole body) $=0.77Ao$,

K_BAo (for "bone") $=0.405Ao$,

K_TAo (for "soft tissue") $=0.365Ao$

where Ao is the administered dose.

Calculation of P^{32} Decayed in the Body. It has been observed following administration of metabolite radioisotopes (P^{32}, I^{131}) that the excretion rate, after an initial erratic behavior lasting from one to three days, tends to follow an exponential path. That is, the amount of metabolite in the body decreases by a constant fraction in a given interval. This similarity to radioactive decay suggests an extension of the concepts found useful to include "excretion decay." The terms biological half-life, effective decay rate, are used by various authors, although not with the same meanings. The amount of the radioactive metabolite present in the tissue depends upon two factors: the biological excretion rate and the physical radioactive decay rate.

The symbols used in the present calculations have been defined and differentiated as follows:

T = Physical half-life of an isotope.

λ = Radioactive decay constant of an isotope.

fd = Daily fractional decay of an isotope.

* Assuming the percentage of "bone" of the body mass to be 10 per cent.

T_B = Biological half-life of an isotope in the body (due to excretion alone and without radioactive decay).

λB = Biological excretion constant (instantaneous excretion rate without radioactive decay).

fd_B = Daily fractional excretion of an isotope (without radioactive decay).

T_E = Effective half-life of a radioactive isotope in the body due to the combined effects of decay and excretion.

λE = Effective loss constant of a radioactive isotope in the body.

fdE = Daily fractional loss of a radioactive isotope in the body.

The interrelation of these symbols can be shown to be:

$$e^{-\lambda Et}=e^{-\lambda Et}\times e^{-\lambda t} \tag{14}$$

$$e^{-0.693t/T_E}=e^{-0.693t/T_B}\times e^{-0.693t/T} \tag{15}$$

$$fd=1-e^{-\lambda t_1} \tag{16}$$

$$fd_B=1-e^{-\lambda Bt_1} \tag{17}$$

$$fd_E=1-e^{-\lambda Et_1} \tag{18}$$

where $t_1=1$ day and

$$fd_B=\frac{fd_E-fd}{1-fd} \tag{19}$$

$$fd=\frac{fd_E-fd_B}{1-fd_B} \tag{20}$$

$$fd_E=\frac{A_t-A_{t+1}}{A_t} \tag{21}$$

where A_t and A_{t+1} are the amounts of isotope present in a compartment of the body on successive days.

Calculation of dose due to decay in the whole body and soft tissue compartments during the first three days differs from that in the bone compartment. For the first three days from an amount of $P^{32}=A$, a fractional amount $fd\times A$ will have decayed in one day. If the P^{32} is being excreted from a compartment at the rate of fd_BA_t per day the total amount decayed will evidently consist partly of decay outside the compartment and partly of decay inside the compartment. Letting Dc be the decay in the compartment, then:

$$Dc=fd\times A_t-fd(fd_B\times A_t)$$
$$=fdA_t(1-fd_B)$$

but from (19) and 20):

$$Dc=fdA_t\left[1-\left(\frac{fd_{E-fd}}{1-fd}\right)\right]$$
$$=fdA_t\left[\frac{1-fd_E}{1-f_d}\right]$$
$$=fdA_t\left[\frac{1-\left(\frac{A_t-A_{t+1}}{A_t}\right)}{1-fd}\right],$$

$$Dc=A_{t+1}\,\frac{fd}{1-fd}. \tag{22}$$

Thus if the amounts of P^{32} present in a compartment for the first three days are A_0, A_1, A_2 and A_3, then the total amount decaying in the body will be:

$$Dc=\frac{fd}{1-fd}\,(A_1+A_2+A_3). \tag{23}$$

Applying equation (23) to the whole body and "soft tissue" retention values from Figure 10,

$$D_{WB}=\frac{0.0467}{1-0.0467}\,(90+83+77)Ao$$
$$=0.049(250)Ao=0.122Ao. \tag{24}$$
$$D_T=0.049(69.8+52.7+36.5)Ao$$
$$=0.049(159)Ao=0.078Ao. \tag{25}$$

For the bone compartment, because of the first three days' accretion of P^{32}, the influx of activity must be taken into account.

From Figure 10 the amount of P^{32} in the "bone" at any time $0\leqq t\leqq 3$ is:

$$A_t=A+Kt \tag{26}$$

where

$A=10\%\ Ao$ and $K=10.17\%\ Ao$/day

the amount, dD_B, decaying in a short time, dt, is:

$$dD_B=(A+Kt)dt\times\lambda \tag{27}$$

and the total amount decaying in the bone for the three day period is:

$$\int dD_B=\lambda\int_0^3 (A+Kt)dt$$

$$=\lambda[(At+Kt^2/2)]^3_0=\lambda(3A+4.5K). \tag{28}$$

$$D_B=0.0478(9.30Ao+4.5(0.1017Ao))$$

$$=0.0478(0.757Ao)=0.036Ao. \tag{29}$$

After the third day, given an amount, $KcAo$, present in a compartment on the third day, the amount present t days later is:

$$KcAoe^{-\lambda_E t} \tag{30}$$

and the amount decaying in the compartment in a short time dt is:

$$dDc=\lambda KcAoe^{-\lambda_E t}dt. \tag{31}$$

The total amount decaying in the compartment after the third day will then approach:

$$\int dDc=\lambda KcAo\int_0^\infty e^{-\lambda_E t}dt$$

$$=\frac{\lambda}{-\lambda_E}KcAo(0-1).$$

$$Dc=\frac{\lambda}{\lambda E}KcAo=\left(\frac{.693}{T}\Big/\frac{.693}{T_E}\right)KcAo$$

$$=\frac{T_E}{T}KcAo. \tag{32}$$

Since $T=14.5$ days, $T_E=11$ days, $K_{WB}=0.77$, $K_T=0.365$, $K_B=0.405$ (32) yields:

$$D_{WB}=\frac{11}{14.5}\times 0.77Ao=0.585Ao \tag{33}$$

$$D_T=\frac{11}{14.5}\times 0.365Ao=0.277Ao \tag{34}$$

$$D_B=\frac{11}{14.5}\times 0.405Ao=0.76\times 0.405Ao$$

$$=0.308Ao \tag{35}$$

Using the results obtained above in equations (24),)25), (29), (33), (34) and (35) total fractions of the administered dose decaying in the three compartments are:

$$\Sigma D_{WB}=(0.122+0.585)Ao=0.707Ao$$

$$\Sigma D_T=(0.078+0.277)Ao=0.355Ao$$

$$\Sigma D_B=(0.036+0.308)Ao=0.344Ao$$

Thus bone receives 49 per cent and soft tissue receives 51 per cent of the whole radiation dose. It should be remembered, however, that bone constitutes only approximately 10 per cent of the body mass. In terms of specific concentration the bone receives about nine times as much radiation as the soft tissue.

When we now consider a patient weighing M kilograms given Ao μc. of P^{32}, the mass of the bone $=100M$ grams and that of the soft tissue $=900M$ grams. The concentration, Cd, in μc. destroyed/gram $=0.344A_0/100M$ for bone and $0.356Ao/900M$ for soft tissue.

Since

$$D \text{ in gm-r/gm.}=88\overline{E}_\beta TCd$$

where

$$\overline{E}_\beta=0.695 \text{ mev.}, \quad T=14.3 \text{ days}$$

then

$$D_B=887\times Cd \text{ gm-r/gm.}$$

$$D_B \text{ (bone)}=887\times 0.344Ao/100M$$

$$=3.05Ao/M \text{ gm-r/gm.}$$

and

$$D_T \text{ (soft tissue)}=887\times 0.356/900W$$

$$=0.351Ao/M \text{ gm-r/gm.}$$

The total integral doses are:

$305Ao$ gram-roentgens for bone, and

$316Ao$ gram-roentgens for soft tissue.

The total body integral dose $=621Ao$ gram-roentgens.

It should be remembered that by definition the gram-roentgen refers to an unspecified mass.

Example:

A 64 kg. patient received 2,000 μc. P^{32} followed on the sixth day by 2,000 μc. more and on the thirteenth day by another 2,000 μc.

The soft tissue dose obtained from Figure 11

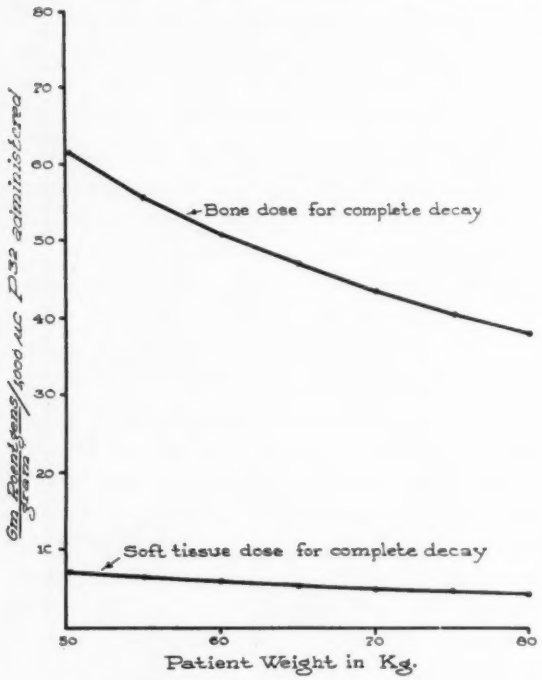

FIG. 11. The "soft tissue" and "bone" compartment expected final dose rate expressed in gm-r/gram per millicurie of administered P^{32} for patients weighing between 50 and 80 kg.

is: 6×5.4 gm-r/gm. $= 32.4$ gm-r/gm.; the bone dose is: 6×48.0 gm-r/gm. $= 288$ gm-r/gm.

The total integral dose is then:

In bone:

$$288 \times \frac{1}{10} \times 64{,}000 = 1.84 \text{ megagram-roentgens.}$$

In soft tissue:

$$32.4 \times \frac{9}{10} \times 64{,}000 = 1.87 \text{ megagram-roentgens.}$$

From Figure 12 it is evident that the highest bone dosage rate occurs on the 16th day—three days after the third administration, while for soft tissue the maximum occurs on the 13th, the day of administration of the last dose. The actual values of these maxima are: for bone, 10.9 gm-r/gm., and for soft tissue, 2.0 gm-r/gm.

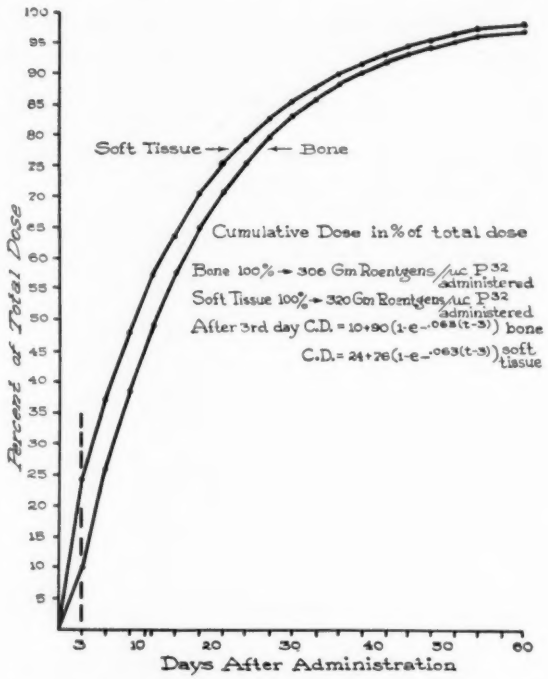
Soft Tissue
Bone
Cumulative Dose in % of total dose
Bone 100% = 306 Gm Roentgens/μc P32 administered
Soft Tissue 100% = 320 Gm Roentgens/μc P32 administered
After 3rd day C.D. = 10+90(1-e^-.068(t-3)) bone
C.D. = 24+76(1-e^-.063(t-3)) soft tissue
Percent of Total Dose
Days After Administration

FIG. 12. The cumulative dose received by each gram of "soft tissue" and each gram of "bone" expressed in per cent of the expected final dose rate (from Fig. 11) any number of days after administration of P^{32}.

SUMMARY

In Part I of this report the distribution of intravenously administered P^{32} is discussed. It is shown that the differential concentration of intravenously administered radiophosphorus between soft tissues and bone-spleen-liver tissues makes it advisable to calculate the radiation dose in these two compartments separately. The dose in these two compartments is referred to as "bone" dose and "soft tissue" dose, respectively.

Evidence is presented from experimental data which justifies the assumption that after a three day "equilibration" period the concentration ratio between the "bone" compartment and "soft tissue" compartment is 10:1. Taking into account the concentration changes in the first three days, this results in a "bone" to "soft tissue" dose ratio of 9:1.

In Part II of this paper the charting of

treatment and the practical use of special dose-record forms is presented.

Part III deals with the derivation of the formulae used in the dose calculations based upon the two compartment distribution of P^{32}.

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THE METABOLISM OF RADIOACTIVE IODINE (I^{131}) IN PATIENTS WITH CARDIAC DISEASE*†

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INTRODUCTION

WITH release by the Atomic Energy Commission of many radioactive elements for civilian use, these materials have rapidly assumed an important position in the armamentarium of the physician, both as regards diagnosis and treatment of a host of disease entities. In particular, radioactive iodine (I^{131}) with a half-life convenient for biological purposes and a high specificity for thyroid tissue has proved to be one of the most valuable of the radioelements. While the actual contribution of the I^{131} tracer to thyroid diagnosis has recently been questioned,[10] most investigators feel that by its use the clinician is often able to estimate the extent of thyroid function, both qualitatively and quantitatively, in a manner not always possible before the widespread diagnostic use of such tracer determinations.

Although there is as yet no widespread uniformity in methods employed for the assay of thyroid physiology by this method, most investigators have come to agree that the level of total thyroid gland function can be directly related to the absolute quantity and rate of I^{131} concentration in the thyroid following injection or ingestion of tracer material. For the estimate of total uptake, some investigators have measured the gamma radiation of I^{131} at a distance using a more or less collimated Geiger or scintillation counter. Distances of at least 22 to 50 cm. are usually recommended in order to render the thyroid in effect a point source of radiation.[3,6,9,18] Clinically satisfactory results, however, have been reported with properly constructed systems using Geiger counter distances as low as 10 to 15 cm.[7,20,21,22]

Other investigators have determined total urinary excretion of I^{131} over suitable intervals following administration of the tracer material and have thus derived total gland uptake from this.[5,12] It has also been possible to derive exponential formulas from such excretion data to express quantitatively the interrelationship between rates of renal excretion and thyroid uptake respectively.[8] Such systems, of course, must assume effectively complete excretion and localization of the tracer material in the thyroid gland over the time interval studied.

More recently, investigators have stressed the value of determining the rate of thyroid uptake as a function of blood or plasma I^{131} concentration (plasma clearance[14,15]). The level of total gland activity has also been estimated by measurement of protein bound I^{131} appearing in the plasma at suitable intervals after oral administration of the tracer.[4,13,16] At all events, it is apparent that the avidity of the thyroid tissue for iodine provides the basis for estimation of total gland function.

That certain drugs (iodine, thiouracil, thiocyanate, and the sulfonamides) are capable of abolishing temporarily the normal iodine hunger of the thyroid has become apparent in recent years. The dangers inherent in forming conclusions as to gland function in the face of prior treatment with these agents are now well recognized. Not so well appreciated, however, is the possibility of inducing similar blocking effects by the presence of renal or cardiovascular pathology in the subject studied. That these abnormalities may induce significant alterations in the total gland uptake has been suggested by some investigators.[11,12,19]

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In the radioisotope laboratory at Harper Hospital we have been concerned over the effects of abnormal cardiovascular physiology upon the I^{131} concentration by the thyroid gland. This has been of special concern, since thyroid disease is capable of compromising seriously the integrity of cardiovascular function and it therefore often falls upon the clinician to determine what part such disease may contribute to the over-all picture of cardiac arrhythmias accompanied by varying degrees of congestive failure. As stated, some have suggested that I^{131} physiology may be seriously altered in such cases. For this reason, the present investigation was instituted in an attempt to delineate more precisely the effects of varying degrees of cardiac failure upon thyroid concentration of administered I^{131}.

METHODS

All patients in this investigation were studied in the manner previously described. Briefly recapitulated, the procedure is as follows:

The subject is given a 50 microcurie carrier-free dose of I^{131} orally before breakfast on the initial day of study. Following this, serial contact counts are made over the thigh, liver, left upper quadrant, cardiac apex, thyroid gland and upper thorax—beginning two hours following ingestion of the I^{131} and continuing for a total of thirty to thirty-six hours. Counts are made with a standard, thin mica-window, Geiger-Müller counter shielded with 1.5 cm. of lead and attached to a suitable scaling unit. During the period of study all urine is collected and its radioactivity determined quantitatively so that a cumulative excretion curve may be plotted over the period of observation. In our studies we have found the normal total urinary I^{131} excretion to range in the vicinity of approximately 25 per cent to 45 per cent at the end of twenty-six to thirty-four hours. It is to be emphasized, however, that there is no general agreement as to what constitutes a normal, hyperurinary and hypo-urinary excretion. Results reported by various investigators have differed widely as functions both of the laboratory reporting and of geographical origin of subjects studied.[5,8,10,12,17]

The patients studied have been divided into two groups, control and experimental. Material for the analysis has been obtained from the radioactive iodine tracer case records of patients studied in the Department of Radiological Research, Harper Hospital. The experimental group is made up primarily of a series of 14 subjects having unequivocal signs and symptoms of cardiac decompensation at the time of study—on the basis of rheumatic, arteriosclerotic, hypertensive, or thyrotoxic heart disease. These patients all had gross peripheral edema at the time of study, some with ascites and hepatic or splenic enlargement. As the pattern of iodine metabolism became evident in such patients, a second group was added to this experimental series. This comprised patients without gross edema but with a history of cardiac decompensation immediately prior to tracer study, or patients giving evidence of impending failure at the time of study on the basis of severe cardiac disease. This group included 6 cases, bringing the total in the experimental series to 20 cases. No patient in these groups was accepted if there was any history of antithyroid medication in the three weeks preceding study.

The control group of 44 patients to be compared to the foregoing was chosen so as to include 21 normal patients, 12 thyrotoxic and 11 patients having marked hypothyroidism as judged primarily by total urinary excretion. Because of divergent urinary excretion results mentioned in the experience of various investigators, we have attempted to choose our hypothyroid and hyperthyroid cases from the extremes of our series as judged by total excretion. Beyond the possession of sufficiently accurate tracer data over a suitable time interval, the only criteria used to select the control series were two-fold:

1. No patient was selected who gave evidence of significant cardiac or renal disease at or preceding the time of study.

2. No subject was used who gave a history of recent medication with drugs affecting thyroid function (iodine, thyroid extract, thiouracil, or its derivatives, thiocyanate or any member of the sulfonamide group).

RESULTS

The effects of severe cardiovascular disease upon the metabolism of I^{131} may be delineated by observation of the soft tissue retention, thyroid gland uptake and urinary excretion of the tracer material. Estima-

tion of total tissue retention is best approximated by consideration of the Geiger-Müller counting rate observed over the large tissue masses of the thigh and liver areas at varying times after ingestion of the I^{131}. In Figures 1, *A*, *B*, *C*, and 2, *A*, *B*, *C* are illustrated the clearance of the I^{131} from these areas as a function of time in those patients whose total urinary I^{131} excretion fell within the normal, hyperthyroid and hypothyroid ranges respectively. Corresponding determinations from the experimental series are plotted in Figures 1*D* and 2*D*. It will be observed that, in general, where patients showed no cardiovascular disease, the tracer material was almost completely cleared from the peripheral tissues in the interval between twenty-six to thirty-four hours, while those subjects who manifested cardiac abnormality exhibited varying significant degrees of soft tissue I^{131} retention in the same time interval. For the purposes of classification, counting rates (above background) of 40 counts per mintue for the thigh and 80 counts per minute over the liver may be accepted as representing the upper limits of the normal range for I^{131} soft tissue content at the end of this period. Hyperthyroid patients, it will be noted, exhibited a tendency toward higher I^{131} content in the hepatic area until the upper limit of the prescribed time interval (Fig. 2*B*), although these same subjects showed accelerated mobilization of I^{131} from the thigh (Fig. 1*B*). In other subjects, rates of clearance from these two areas roughly paralleled one another.

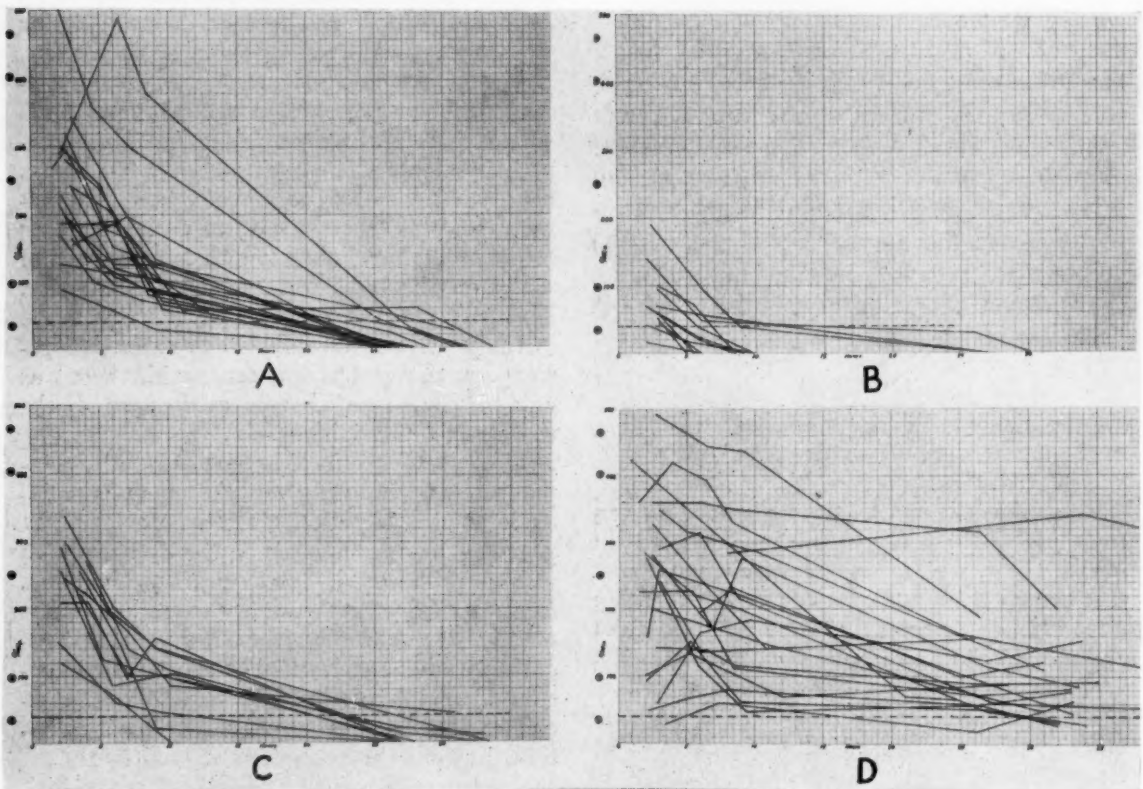

FIG. 1. Clearance of I^{131} from the thigh. Contact Geiger-Müller count rates (less background) versus time. (*A*) Normal patients. (*B*) Hyperthyroid patients. (*C*) Hypothyroid patients. (*D*) Patients with cardiac disease.

As might be expected, the high soft tissue retention described in the experimen-

tal series was not without effect upon the total thyroid I^{131} uptake. Under other circumstances, total thyroid I^{131} content may be satisfactorily determined by difference when the total urinary excretion of the material is calculated and the material is known to have been effectively cleared from the peripheral soft tissues. Such a method would, of course, be seriously in error if applied to our experimental series. Probably the true I^{131} content of the thyroid under these conditions could be determined only through use of a properly collimated detector (i.e., a scintillation counter) at a relatively large distance from the gland itself. However, a semiquantitative estimate of uptake may be gained from consideration of contact counting rate over the thyroid isthmus at the period of greatest I^{131} concentration between twenty-four to thirty-four hours. Despite the obvious geometric inadequacies inherent in such a count designed primarily as part of an anatomical mapping procedure we have employed, such a determination provides a clinically satisfactory estimate of gland uptake for our present purposes.

In Figure 3 a scatter plot is given with the maximum thyroid isthmus counting rate per minute (ordinate) plotted against total urinary excretion at thirty hours (abscissa). A solid curve has been drawn through the averages obtained in the three subdivisions of the control series (normal, high and low total urinary excretion) with respect to both axes. It will be seen that an approximately reciprocal relationship obtains in the relationship of these two variables. Superimposed upon these data is a similar plot of thyroid isthmus—urinary excretion relationships in the experimental series. Here there can be observed a mark-

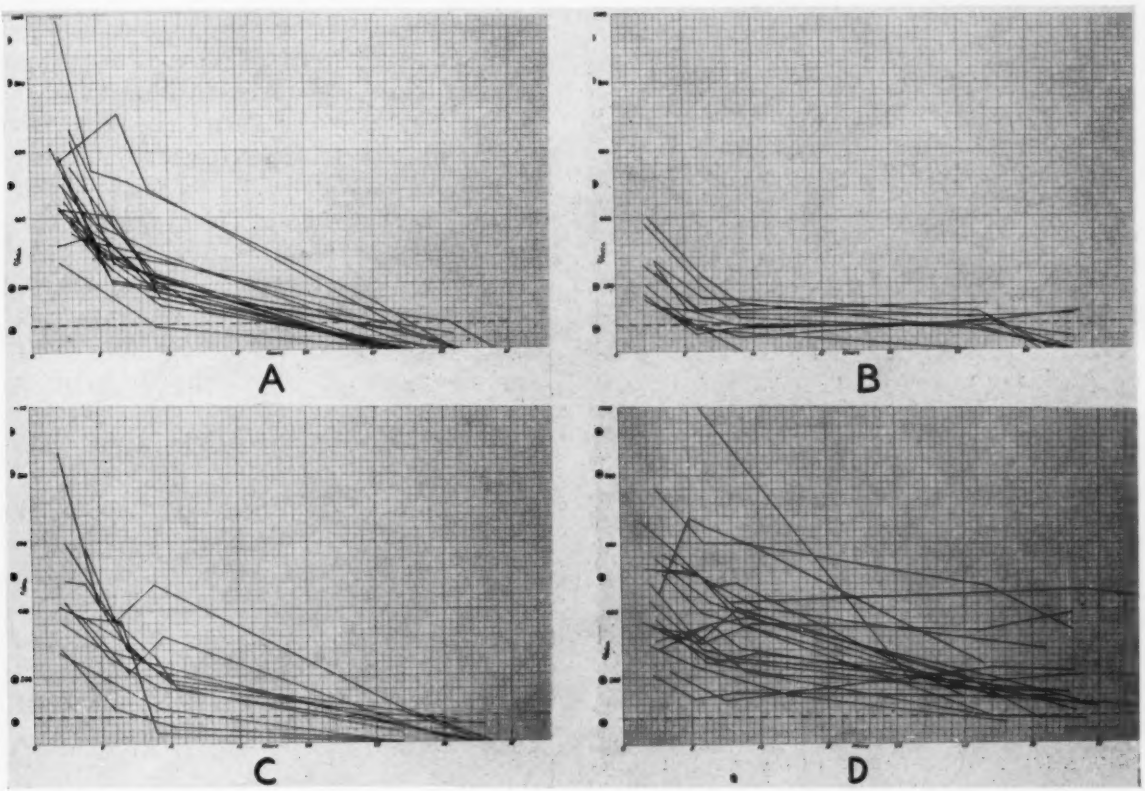

Fig. 2. Clearance of I^{131} from the liver. Contact Geiger-Müller count rates (less background) versus time. (*A*) Normal patients. (*B*) Hyperthyroid patients. (*C*) Hypothyroid patients. (*D*) Patients with cardiac disease.

edly diminished efficiency of I^{131} concentration in the thyroids of these experimental patients despite varying levels of total urinary excretion. Because of delayed mobilization of the tracer material from the

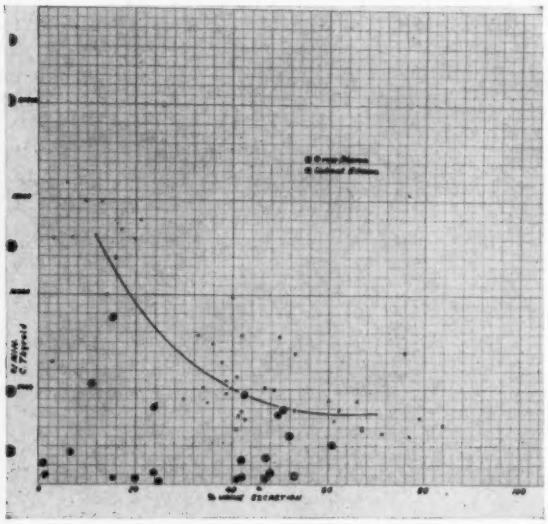

FIG. 3. Scatter plot of maximum contact Geiger-Müller counting rates over central thyroid area (ordinate) versus total urinary I^{131} excretion at thirty hours (abscissa).

tissues, only 6 patients in the group were able to concentrate the iodine to a maximum of 3,000 counts per minute, or above, in the isthmus area (normal patients usually vary around a mean of 5,000 per minute according to our method). The counts on one experimental patient in whom no edema was grossly manifested rose into the thyrotoxic range.

Inspection of Figure 3 also reveals the wide range of total urinary I^{131} observed in the test series. Levels of iodine excretion are scattered throughout the interval between 1.0 per cent and 60 per cent. Analysis of the shape of the excretion curves, however, reveals certain deviations from the normal worthy of comment. Ordinarily the urinary excretion of ingested I^{131} follows closely an exponential pattern with a rate constant whose parameters have been described as functions of renal and thyroid clearance of the circulating tracer. Under conditions observed in this laboratory such curves in patients having no cardiovascular or malignant thyroid disease tend to flatten asymptotically after one day so that relatively negligible increments of I^{131} are added to the total excretion between twenty to thirty hours of study. When the absolute amount of activity excreted during this period (suitably corrected for radioactive decay) is expressed as a per cent of the total excretion at thirty hours, some idea may be gained as to the actual rise of the curve in the interval. We have preferred to relate the urinary increments to the total excretion in this manner, rather than to express excretion rate as a pure mathematical slope. The rationale for this procedure is based on the experience that high excretion curves (net hypothyroid) level off appreciably later than do most low (hyperthyroid) curves (Fig. 4).

Application of this principle to the cases under consideration reveals that none of the 44 control subjects excreted over 11 per cent of the thirty hour total I^{131} in this ten hour period, whereas 13 cases of the experimental series rose well above this figure, excreting as much as 20 to 30 per cent of the thirty hour total in this time interval. Of the other 7 patients, 5 showed

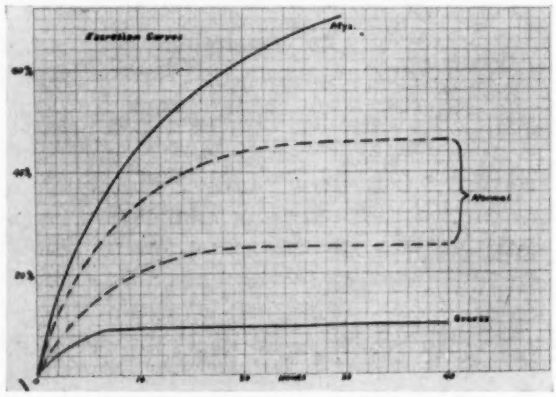

FIG. 4. I^{131} urinary excretion curves in hypothyroidism and hyperthyroidism.

excretion curves not significantly different from the control group in this respect, while the remaining 2 subjects were in such advanced cardiac failure that entirely

negligible amounts of I^{131} were eliminated throughout the whole period of study (1 per cent and 1.5 per cent total I^{131} excretion in thirty-seven and forty-eight hours respectively). As a direct result of this delayed excretion, the curve of a typical edematous patient tended to straighten out toward a linear function of time as opposed to the normal exponential relationship (Fig. 5).

That the total I^{131} excretion is related to cardiovascular integrity may be illustrated by reference to Figure 6, representing urinary excretion data of two tracer studies on the same patient. This patient, a white female, aged sixty-nine, gave a history of recurrent decompensation over a two year period preceding entry treated by digitalis

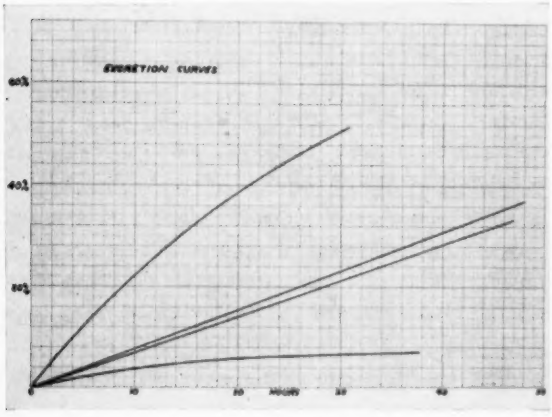

Fig. 5. Curves showing typical I^{131} urinary excretion in patients with severe cardiac disease.

and mercurials. At the time of the initial tracer study, the patient was in advanced decompensation with marked cardiac enlargement, uncontrolled auricular fibrillation, basilar lung congestion, hepatomegaly and pitting edema over the entire abdominal wall and lower extremities. Curve A of Figure 6 depicts the pattern of urinary excretion at that time. The curve was linear and rose to only 15 per cent in fifty hours, while at the same time the counting rate over the thyroid area never exceeded 6 to 8 per cent of the expected normal. These results were coupled with high counts over the soft tissues peripherally. At the end of seventeen days, compensation had

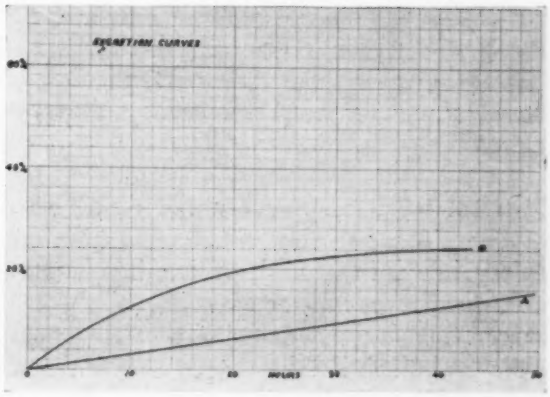

Fig. 6. I^{131} urinary excretion curves on same patient obtained while decompensated (A) and after cardiac compensation had been restored (B).

been restored in this patient via bed-rest, digitoxin, mercurials and ammonium chloride so that gross peripheral edema and pulmonary congestion had disappeared. Tracer study at that time revealed a total I^{131} excretion of 24 per cent (curve B, Fig. 6) accompanied by counting rates over the thyroid area well within the normal range. It should be emphasized that soft tissue counts remained high in this patient despite marked clinical improvement.

Similar soft tissue retention is often seen in studies conducted on patients with severe but "compensated" cardiac disease. This is demonstrated in the 6 patients included in our experimental series showing definite evidence of compromised cardiac function without clinical edema (latent edema). The metabolism of I^{131} in these subjects paralleled in all respects that noted in the grossly edematous patient.

DISCUSSION

It will be seen from the foregoing data that cardiovascular incompetence is capable of altering profoundly the metabolism of I^{131}. It would appear that most of the abnormalities actually observed can be explained purely on the basis of disturbance in the extracellular fluid and electrolyte components of the body along with the resulting compromise of renal integrity. Certainly high soft tissue retention of

I^{131} in the thigh and liver areas must be a direct consequence of increased capillary permeability with diffusion of tracer material into the extracellular spaces and delayed mobilization therefrom.

In the past two years of study at this hospital we have never failed to observe evidence of I^{131} soft tissue retention at thirty hours in a subject showing detectable cardiac edema at the time of the I^{131} tracer. The incidence of similarly abnormal I^{131} metabolism in cardiac patients without gross edema cannot be stated, but our studies suggest that appreciable numbers in this group may exhibit significant alterations from the normal. In fact, in several cases at this institution within the past two years the presence of occult edema has been first demonstrated by characteristic I^{131} tracer changes confirmed by subsequent development of clinically demonstrable decompensation.

The control patients generally failed to exhibit such changes, although a tendency toward elevated counts over the liver was noted in the hyperthyroid group until relatively late during the period of study. This observation may, in part, be explained by the early elaboration of active thyroid hormone from the hyperplastic glands of these subjects. Evidence has been adduced to indicate that radiothyroxin administered orally or intravenously is selectively concentrated by the liver for several hours.[1,2] Albert and Keating suggest that liver tissue apparently provides one region into which thyroxin may diffuse from the plasma component with relative ease.[1]

Explanation of deficient thyroid concentration of I^{131} with abnormalities in the configuration of the urinary excretion curve in patients with cardiac disease may also be rationalized on a similar basis. Keating *et al.*[8] have described urinary excretion of I^{131} in terms of the function $\mathcal{Q}=\mathcal{Q}_f(1-e^{-rt})$ where $\mathcal{Q}$ is the amount of I^{131} expressed as a fraction of the original dose excreted in the urine in time (t); $\mathcal{Q}_f$ is the asymptotic amount excreted at infinite time and r is a constant dependent on the rate of I^{131} disappearance from the blood. It must be realized that this constant, r, is in turn a function of all factors tending to reduce blood I^{131} concentration. Ordinarily renal excretion and thyroid uptake make the only significant contribution to the actual value attained by this constant. However, where a patient has significant cardiac disease, it is evident that another parameter asserts itself in the relatively large amounts of iodine which may be sequestered in the water-logged extracellular compartment for periods of time long in comparison to the duration of tracer study. Thus, not only is the kidneys' contribution to this value reduced by decreased renal clearance, but the total concentration of I^{131} presented to the thyroid for clearance is markedly reduced by dilution of the tracer in the edematous tissue. This delay in mobilization may explain, in part, the linear aspect of urinary excretion curves obtained in edematous patients, since it is most difficult to differentiate in early phases a linear from a true negative exponential relationship where the rate constants in the latter are small with respect to unity.

That a true inhibition of thyroid uptake may also prevail in these experimental subjects is suggested by the markedly diminished I^{131} uptake observed in the thyroids of 5 of the 6 patients showing no clinical evidence of gross edema (Fig. 3). Moreover, the speculation of Keating *et al.*[8] suggests that where renal excretion of I^{131} s impaired, as in cardiac edema, persistence of I^{131} in the vascular compartment should tend to produce a net, though delayed, elevation in total I^{131} uptake by the thyroid. The tendency of thyroid collection here has been in the opposite direction of lowered gland uptake regardless of the length of time studied up to several days. It is possible that the thyroid's contribution to the exponential clearance rate, r, may have been depressed independently of the other parameters.

Whatever may be the precise etiology of

the depression in thyroid uptake here observed, it will be apparent that tracer evidence of hypothyroid function in patients with significant cardiac disease with or without gross edema must be viewed with some reservation. This is of particular importance where the clinician suspects masked hyperthyroidism underlying a cardiac abnormality. Even where gross failure has not supervened, the occurrence of persistently high tissue counts, and unduly depressed thyroid uptake following ingestion of I^{131} tracer, often with a gross distortion in the pattern of normal urinary excretion, should not fail to put the clinician on guard against the existence of normal to excess thyroid function, even in the face of apparently contrary tracer evidence.

SUMMARY

1. The metabolism of I^{131} in twenty patients suffering from severe cardiac disease has been studied. Of this group, fourteen subjects had gross evidence of cardiac failure, while the remaining six showed no definite clinical edema at the time of study. The results in this group have been compared with those obtained in a series of patients showing no significant cardiac disease, but having varying levels of total thyroid function as judged by total urinary I^{131} excretion.

2. Results of this work indicate that certain characteristic abnormalities of I^{131} metabolism obtain in patients with cardiac decompensation. These include marked soft tissue retention of I^{131} from twenty-four to thirty-six hours after ingestion of the material together with deficient I^{131} concentration in the thyroid gland during this time. In addition, certain changes in the pattern of urinary I^{131} excretion throughout the period are noted.

3. Attention is called to the fact that these changes in the metabolism of I^{131} may on occasion mask the presence of latent thyrotoxicosis in a patient with cardiac disease. In still other situations, the existence of occult edema as a harbinger of gross cardiac decompensation may be detected by I^{131} tracer study before characteristic prodromal signs and symptoms become evident clinically.

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FURTHER OBSERVATIONS ON THE DIAGNOSTIC VALUE OF PULMONARY ANGIOGRAPHY IN BRONCHIOGENIC CARCINOMA*†

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CANCER of the lung continues to offer difficulties in diagnosis. This is especially true in the early stages when it simulates an inflammatory reaction. Atelectasis and pneumonia usually develop concomitantly and may incite symptoms which cause the patient to seek medical attention. Often carcinoma is considered only after there is failure to respond to antibiotic and other medical therapy. Valuable time is thereby lost. This delay is partly responsible for the low operability and curability of carcinoma of the lung. In large series the operability is given as 30 per cent and the five year survival is 8 per cent.[4,5] The commonly employed methods of diagnosis are inconclusive in a significant percentage of cases. Study of the pulmonary vascular tree by contrast visualization is another approach to the diagnosis of carcinoma of the lung.

Previous reports[2,3] deal with pulmonary vascular patterns in 15 and 26 cases of proved bronchial carcinoma. We now have performed this procedure in 40 cases, and have compared the results with other diagnostic studies; bronchoscopy, bronchoscopic biopsy, and microscopic study of aspirated bronchial secretions. This report deals particularly with 10 patients in whom all studies except angiography yielded negative results in the presence of bronchiogenic carcinoma.

TECHNIQUES

A. *Pulmonary Angiography.* The technique of pulmonary angiography has been previously described.[2,6,7] It consists of placing the patient for a posteroanterior film of the chest and rapid serial filming facilitated by a manually operated tunnel device. Fifty cubic centimeters of 70 per cent diodrast are injected rapidly through a 13 gauge needle into the right median basilic vein. When the lesion is in such a location that the stream of diodrast in the subclavian vein would mask part of the pulmonary vascular pattern, the injection is done on the opposite side. Films are taken two, four, six and eight seconds after completion of the injection. The two and four second films outline the right heart and the pulmonary artery and veins. The six and eight second films outline the left heart, aorta and its major branches. In the event of a slowed circulation the exposure times are correspondingly increased.

B. *Microscopic Study of Aspirated Bronchial Secretions.* After localizing the tumor roentgenographically, and after completion of bronchoscopic examination, secretions are aspirated from the involved bronchus. If secretions cannot be obtained, a few cubic centimeters of saline are injected into the bronchus, reaspirated, collected, and sectioned by the technique of Cross *et al.*[1]

OBSERVATIONS

Thirty-seven of the 40 cases of bronchiogenic carcinoma showed characteristic deviation from the normal pulmonary vascular pattern. This consisted of diminished vascularity within and distal to the carcinoma (Fig. 1). Three cases failed to show any deviation from the normal pattern. Two of these had extensive carcinoma involving both main stem bronchi and carina prior to the appearance of a mass roent-

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† Sponsored by the Veterans Administration with the approval of the Chief Medical Director. Statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

TABLE I

RESULTS OF DIAGNOSTIC PROCEDURES IN TEN CASES OF BRONCHIOGENIC CARCINOMA IN WHICH THE PULMONARY ANGIOGRAM SHOWED CHARACTERISTIC ABNORMALITIES ON THE VASCULAR PATTERN. THE OTHER STUDIES WERE NOT DIAGNOSTIC

Case	Location of Lesion	Bronchoscopy	Biopsy	Bronchial Washings	Pulmonary Angiography
I. P.K.	LUL—peripheral	Negative	None	1 to 2 plus	Diminished vascularity LUL
II. O.T.	LUL—peripheral	Negative	None	Negative	Diminished vascularity LUL
III. H.G.	LUL—peripheral	Negative	None	Negative	Obstruction superior branch LPA and diminished vascularity LUL
IV. F.K.	RLL—peripheral	Negative	None	1 plus	Diminished vascularity RLL
V. A.B.	LUL—peripheral	Extrinsic pressure LMB	Negative	Negative	Diminished vascularity LUL
VI. L.C.	L. hilar	Extrinsic pressure RMB	None	Negative	Distortion RPA with diminished vascularity entire right lung
VII. O.A.	RML—peripheral	Narrowing RMLB	None	Negative	Distortion of arterial radicles within mass and diminished vascularity of lower outer portion of lung field
VIII. J.H.	Large mass arising from anterior pulmonary segment and encircling heart	Extrinsic pressure RM and LLB	None	Negative	Diminished vascularity entire right lung
IX. G.B.	L. hilar	Extrinsic pressure LMB	Negative	Negative	Narrowing and distortion of LPA and diminished vascularity of entire left lung
X. A.C.	L. hilar	Narrowing LLB	None	1 plus	Diminished vascularity LLL

genographically. At necropsy there was little pulmonary parenchymal involvement. The other case had a small lesion in a posterior juxtapleural location. This was discovered on a routine chest roentgenogram (the patient having entered the hospital for treatment of another condition). Other diagnostic studies were also negative. Lobectomy was performed and a papillary adenocarcinoma was found.

Ten of the cases are of particular interest since all special diagnostic procedures, except angiography, failed to disclose the nature of the pathological process (Table 1). Seven had peripheral lesions (beyond the range of the bronchoscope). Three had hilar lesions which apparently arose from a small bronchus and exerted pressure on the main stem or lobe bronchus. In none of these was the bronchoscopist able to make an endoscopic diagnosis of carcinoma. Biopsy was attempted in only 2 and these were negative. Studies of bronchial secretions from the suspected bronchus were negative in 7, 1 plus in 2 and 1 to 2 plus in 1. Suspicion of malignancy was graded 1 to 5 plus, 5 plus being considered diagnostic for bronchial carcinoma.

Angiography showed diminished vascularity of the pulmonary parenchyma distal to the lesion in all 10 cases. In addition, 3 showed distortion or narrowing of the pulmonary arterial trunk or its major branches and 1 showed complete obstruction of a major branch of the left pulmonary artery.

There were 2 cases in which the angiogram showed diminished vascularity considered characteristic for neoplasm and no evidence of malignancy was found in the resected specimens. The first of these had a right upper lobe atelectasis and a history of cough, blood-streaked sputum, dyspnea, chest pain and weight loss of several months' duration. Bronchoscopy was noncontributory, there was no biopsy, and microscopic study of aspirated bronchial secretions failed to disclose evidence of malignancy. Lobectomy was performed. A broncholith was found blocking the orifice of the upper lobe bronchus and an extensive chronic inflammatory reaction with scarring had completely obstructed the pulmonary arterial branches to the upper lobe. The second case had atelectasis of the left lower lobe with packing of arterial radicles within this lobe, and a compensatory emphysema with diminished vascularity of the upper lobe. The gross specimen showed a submucosal osteochondroma obstructing the left lower lobe bronchus.

COMMENTS

The finding of diminished vascularity of pulmonary parenchyma distal to a carcinoma has been previously reported,[2,3] The present study is based on the observation of pulmonary angiograms of 396 patients (including the 40 cases of carcinoma). Approximately one-half of the patients had (apparently) normal lungs. The remainder had various types of pulmonary parenchymal disease. Study of gross specimens obtained at surgery or necropsy was possible in most of the cases of carcinoma.*

* We have discontinued making plastic molds of the vascular tree of such specimens because of inherent difficulties with inflation and injection, the multiplicity of artefacts, and because the specimen is lost for all other purposes.

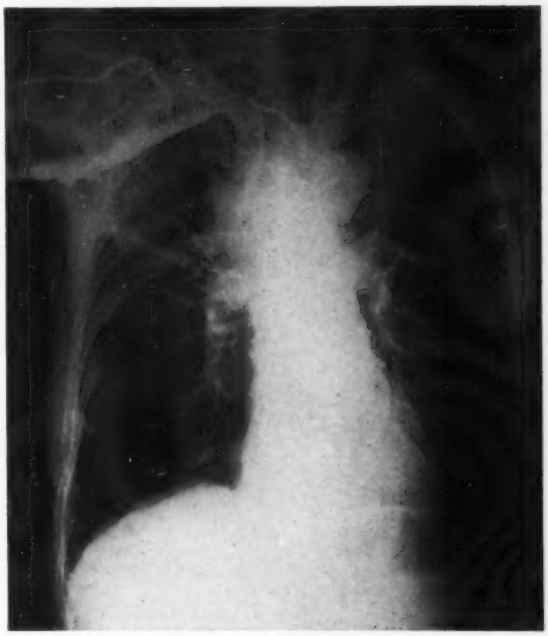

Fig. 1. Pulmonary angiogram two seconds after intravenous injection of 50 cc. 70 per cent diodrast. The vascular pattern of the left lung is normal. The entire right lung shows diminished vascularity distal to a right hilar carcinoma.

Diminished vascularity is manifested on the roentgenogram by reduction in the number and size of vessels in an area of lung, as well as delayed filling in many cases. If the carcinoma is located at the hilus and partially obstructs the main arterial trunk, the entire lung may be less vascular than normal in the presence of a rather small lesion (Fig. 2). Larger hilar lesions may cause distortion of the main pulmonary artery (Fig. 3) and delayed filling of the arterial tree on the affected side. At times the delay may be as long as four seconds (Fig. 4 and 5).

A lesion slightly removed from the hilus may obstruct completely one or more arterial branches. Mid-lung tumors produce distortion of arterial radicles within the mass (Fig. 6). When an entire lobe or lung is infiltrated by neoplasm there is virtually no evidence of filling of the arterial branches (Fig. 7). Only the very small lesions located in the periphery of the lung fail to show changes. Diminished vascular-

FIG. 2. Diminished vascularity of entire left lung in the presence of a small hilar carcinoma.

ity distal to and within the primary tumor mass has been the characteristic finding. This is often associated with distortion of branches or compression upon the main pulmonary arterial trunk.

FIG. 3. Narrowing of left pulmonary artery within tumor mass and diminished vascularity of left lung.

There are other lesions which produce diminished vascularity within the lung parenchyma. Emphysematous blebs are the most common cause in our cases. Since

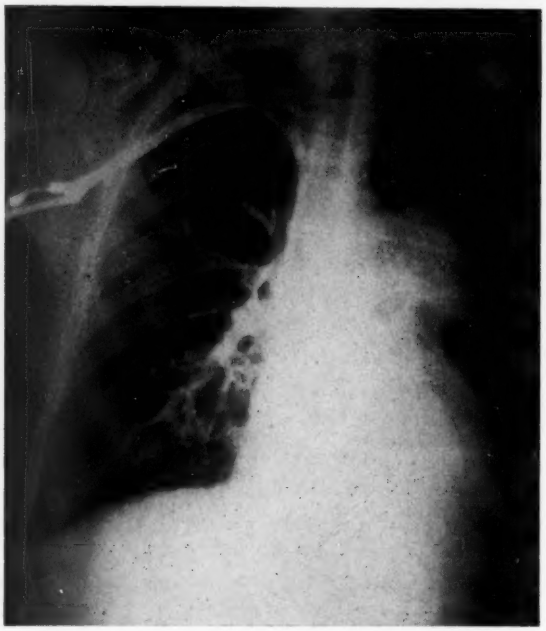

FIG. 4. Two second angiogram showing arterial filling on the right and lack of filling on the left in association with a large hilar carcinoma.

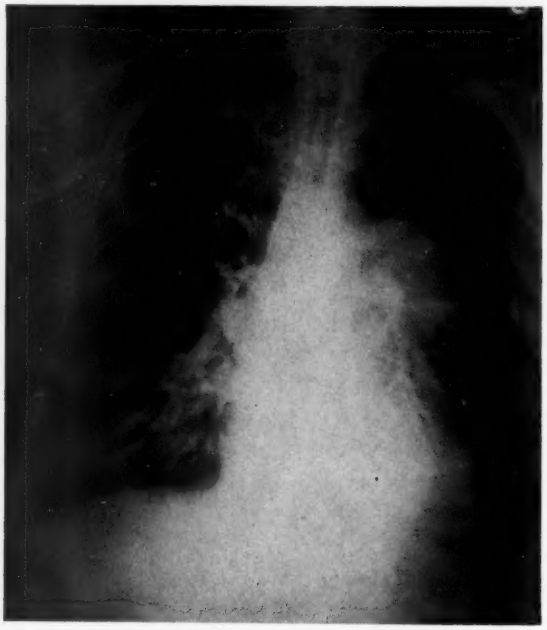

FIG. 5. Six second angiogram of the same case showing delayed filling of the left pulmonary artery.

these are not associated with a mass and are often multiple, we have had no difficulty in distinguishing the picture produced by blebs from that of carcinoma. Naturally a large inflammatory abscess will not show vessels within its cavity. However, there is usually an increase in the vascularity in the surrounding zone of inflammation and the lung parenchyma distal to the abscess shows normal vascularity. When the abscess represents necrosis within a carcinoma, we have found diminished vascularity beyond the lesion in all cases. Senile emphysema bilaterally produces diminished vascularity throughout both lungs, usually equally on the two sides. Obstruction of a major bronchus with lobar atelectasis and compensatory emphysema of the remaining lobe is a common finding in carcinoma, but may be associated with benign lesions such as a foreign body within the bronchus, a mucus plug or a broncholith. In this event the emphysematous lobe is relatively avascular as compared to the opposite lung. In the atelectatic lobe there is packing of the opacified vessels but no obstruction or delayed filling. We failed to take cognizance of this fact in the patient whose lower lobe was atelectatic because of obstruction by osteochondroma. However, since we recommended surgical exploration on the basis of the angiogram, we include the case as a false positive study. This represents an error in interpretation of the angiogram. It is conceivable that a small, completely intraluminal tumor obstructing a bronchus could produce the same appearance, but in our experience a tumor of sufficient size to produce bronchial obstruction also involves vascular structures.

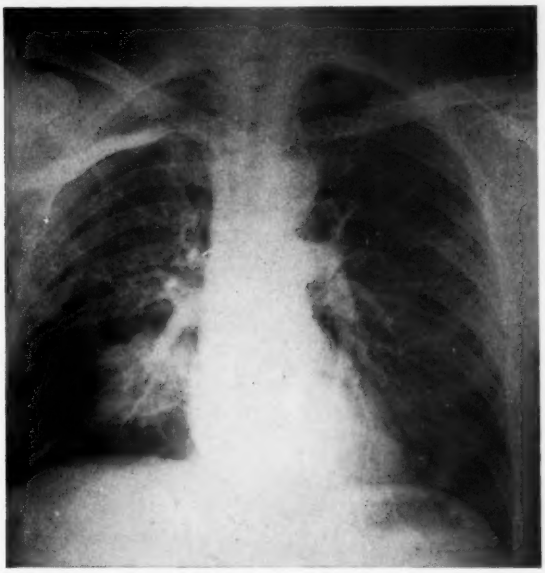

Fig. 6. Distortion of arterial radicles within a right lower lobe carcinoma and diminished vascularity distal to the lesion.

Fig. 7. Markedly diminished vascularity within a left upper lobe carcinoma.

SUMMARY AND CONCLUSIONS

1. Pulmonary angiograms have been performed in forty consecutive cases of bronchiogenic carcinoma. Thirty-seven cases showed characteristic changes in the blood vessel pattern of the involved lung.

2. The most characteristic change was diminished vascularity within and distal to the carcinoma. Less frequent changes were obstruction or distortion of the superior vena cava, the pulmonary arteries or their branches.

3. Ten cases, representing one-fourth of the series, demonstrated this vascular

change in the presence of inconclusive bronchoscopic examination and negative microscopic study of bronchial secretions. These cases demonstrated the importance of pulmonary angiography in diagnosis of lesions which are not readily available to diagnosis by bronchoscopy. They demonstrate further that the microscopic study of bronchial secretions is much more reliable when the lesion is within the reach of the bronchoscope, usually a location where biopsy is possible.

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INSPISSATED TUBERCULOUS CAVITIES

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MUCH has been written concerning the mechanism whereby tuberculous cavities close. The conclusions of more recent workers in the field would indicate that no one single mechanism can explain the method of cavity closure. Coryllos,[2] who wrote extensively on the subject, felt that the draining bronchus became the seat of tuberculous bronchitis; and that the resultant inflammation and fibrosis caused bronchial obstruction. The bronchial obstruction was succeeded by absorption of air from the cavity which led to atelectasis of the cavity and its obliteration.

Auerbach and Green,[1] in an extensive study of postmortem material, concluded that no one mechanism can account for closure of all tuberculous cavities. They believed that obliteration of cavities occurs in two general ways:

1. Open healing in which the cavity lumen remains patent. In this type the draining bronchus opens widely into the cavity lumen. The tuberculous components of the cavitary lesion are replaced by fibrous tissue. The lumen becomes epithelialized by either columnar or squamous epithelium.

2. Closed healing in which the lumen of the cavity either becomes obliterated by a scar or is replaced by retained caseation and inspissation.

Of all these mechanisms, Auerbach and Green found that healing by inspissation is by far the most frequent form.

The prognostic significance of blocked tuberculous cavities has long been a matter of controversy in the literature. The ultimate behavior of these lesions may be of value in determining the course of their therapy. If the inspissated cavity were an unstable type of lesion, prone to break down and discharge bacilliferous sputum into the tracheobronchial tree, then the treatment should be the same as for an open cavity. However, most blocked cavities show no tendency to break down, and provided no other active lesions are present in the lungs, a policy of judicious watchfulness is warranted. Shamaskin,[6] and Study and Morgenstern[7] have been the most recent authors to emphasize the benignity of cavity inspissation. Our series of cases confirms the opinion of these writers.

What criteria, then, are necessary to establish the diagnosis of an inspissated cavity? We believe that initially one should see a definite cavity in the roentgenogram of a given case. This cavity, when followed by interval studies, should fill, and thus cast a shadow of increased density. The resultant opaque shadow should gradually shrink in size. Shrinkage of the lesion over the course of time is an important indicator of stability, since it denotes encapsulation by firm fibrosis. This observation has not received sufficient attention by previous writers on the subject. Only by means of serial roentgen examinations can the diagnosis be made. Without serial films, the differential diagnosis of a blocked cavity becomes the differential diagnosis of a rounded nodular lesion in the lung, and includes such entities as caseous parenchymatous foci, benign and malignant neoplasm, loculated effusions and cysts within the pulmonary parenchyma, etc. A helpful finding in differentiating the inspissated cavity from the other entities is the "tennis racquet" appearance of the tuberculous cavity. This appearance results from the reactive inflammatory change about the draining bronchus of the cavity, and it is almost always a concomitant finding in tuberculous cavities. The presence of tuberculous infiltrates elsewhere in the lungs is also of great help in making the diagnosis. The latter finding, however, may make it impossible in some cases to differentiate the caseous par-

enchymatous focus from an inspissated cavity without the aid of serial films.

One should not confuse the truly inspissated cavity, in which the draining bronchus has become firmly occluded, with those cavities which show transient blockage of the draining bronchus. The latter were described by Pinner,[4] Eloesser,[3] and Salkin, Cadden and McIndoe,[5] and were considered of serious import. The cavities they described were blocked by detritus and mucus plugs, which often had a ball valve action, causing ballooning of the cavities. Almost always, patients with this type of lesion develop the systemic symptoms associated with sputum retention.

The differentiation between the two types of cavities can be determined from the following criteria: The firmly inspissated cavity shows no evidence of systemic reaction, and it undergoes shrinkage over a period of time. The temporarily occluded cavity shows systemic toxemia and either ballooning or failure of contraction of the cavity.

The following 7 cases illustrate the benignity of inspissated cavities and the justification for treating them conservatively. Unfortunately, one cannot foretell which cavities will block, but once they do block and remain blocked, one can feel reasonably secure about their prognosis.

REPORT OF CASES*

CASE I. M. W., female aged twenty-seven, was admitted to Eagleville Sanatorium on September 18, 1935, with minimal involvement at the right apex, and a 3.5 cm. cavity in the left upper lobe. Sputum was heavily positive. Left pneumothorax was attempted, but was unsuccessful, and then a left phrenicectomy was done on October 21, 1935. From December 3, 1935, sputum was consistently negative, and subsequent films showed blocking of the cavity. She was discharged in excellent condition, on all day exercise, on September 30, 1936, "disease arrested," and has since remained well.

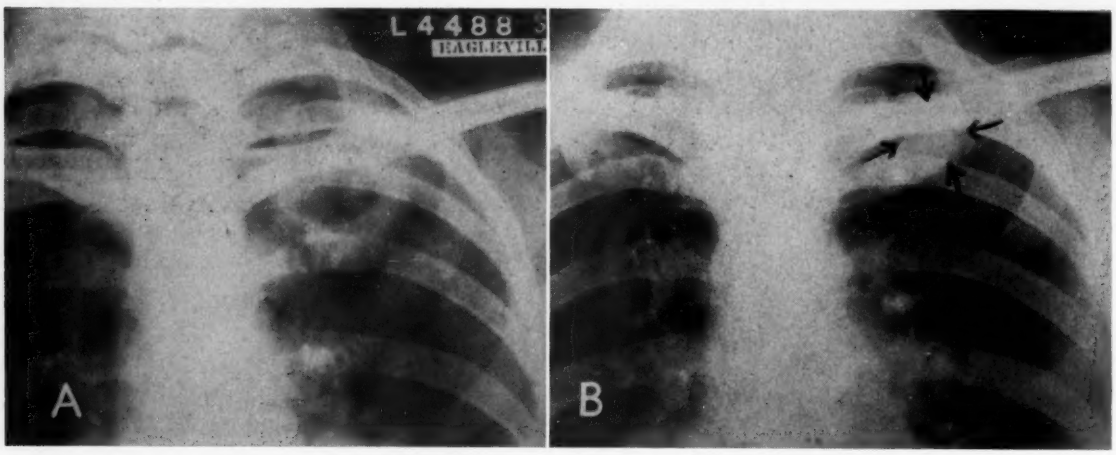

FIG. 1. Case I. (*A*) Shows large cavity in left upper lobe which has shrunk considerably and become inspissated, one year later. (*B*) It is now fourteen years since last roentgenogram and the cavity has remained inspissated.

CASE II. G. N., female aged twenty-three, was admitted to Eagleville Sanatorium on September 10, 1930, with bilateral involvement and a cavity in the lower portion of the left upper lobe. Later, excavation developed in the right upper lobe. Sputum was heavily positive. The patient had bilateral pneumothorax from 1932 to 1934. The cavity on the left blocked, but some excavation was still present on the right. A right phrenic crush was done in May, 1934, and this was followed by a right phrenicectomy in February, 1935. From July, 1935, sputum was consistently negative. The

* Cases reported are from Eagleville Sanatorium, Eagleville, Pennsylvania.

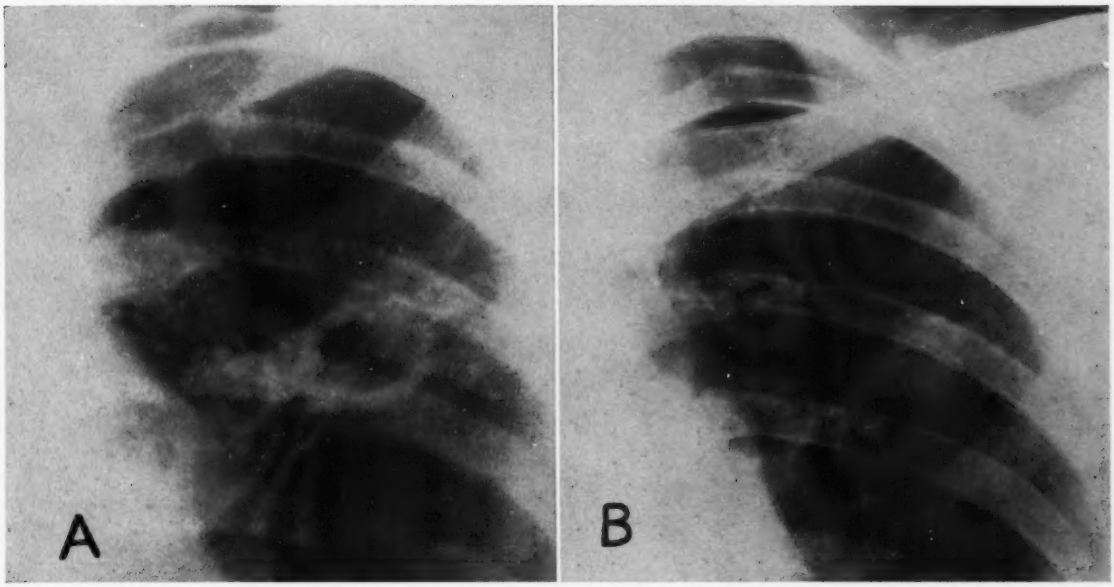

Fig. 2. Case II. (*A*) Reveals an open cavity in the subapical portion of the left upper lobe. (*B*) The cavity blocked and it has remained inspissated to date since 1934.

processes on both sides were apparently organized, and patient was discharged "apparently arrested" on January 26, 1936. She has been well and working at the sanatorium ever since.

Case III. E. C., female, aged thirty-two, was admitted to Eagleville Sanatorium on October 18, 1931, with involvement throughout the right lung and with a cavity just above the right hilus. Sputum was positive. A right phrenicectomy was done on October 21, 1931. The cavity blocked, the patient improved rapidly. She was discharged on November 1, 1931, and she has been well since.

Case IV. M. H., aged forty-seven, was admitted to Eagleville Sanatorium on December 20, 1940, with a right pneumothorax which was begun elsewhere in November, 1940. On admission, a roentgenogram showed a pneumothorax with many adhesions springing from the lower lobe, and a large uncompressed cavity in the right lower lobe, not completely drained. A thoracoscopy was done and no adhesions could be seen. A right phrenic crush was done on June 2, 1941. In August, 1941, the cavity was no longer visible. Sputum fluctuated from negative to positive until July 3, 1941,

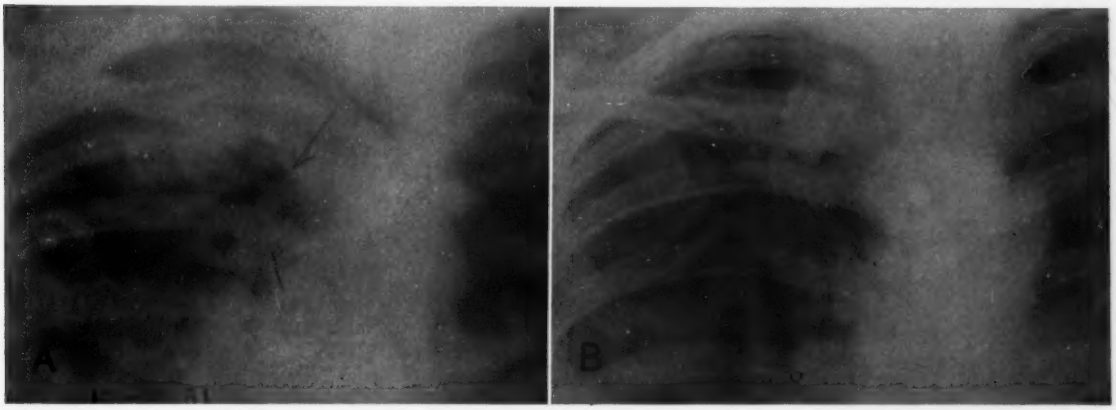

Fig. 3. Case III. (*A*) Discloses a cavity above the right hilus which blocked in 1931. (*B*) Roentgenogram of of the chest seventeen years later. Cavity is firmly inspissated and appears to have moved upward due to fibrosis of right upper lobe and difference in projection of the two films.

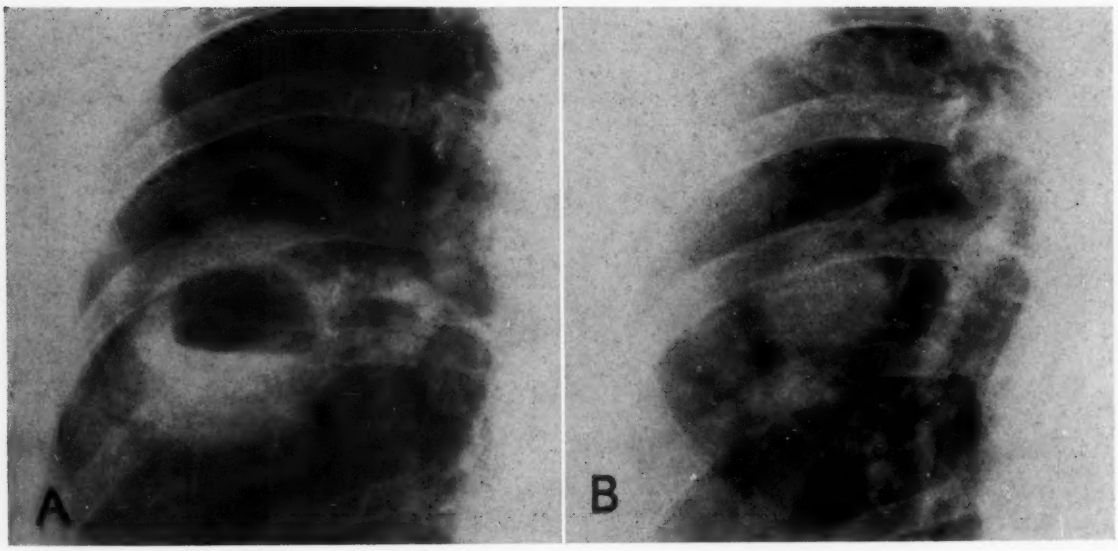

FIG. 4. Case IV. Shows a large cavity with a fluid level situated in the apical segment of the right lower lobe in December, 1940. (*B*) Roentgenogram showing the same lesion which had become inspissated in August, 1941. Note the shrinkage of the cavity due to encapsulation by firm fibrosis.

after which it was negative until discharge. The patient was discharged in excellent condition on December 30, 1941, "apparently arrested," to continue refills of right pneumothorax at the dispensary, and the blocked cavity has remained stabilized.

CASE V. N. Y., male, aged forty-seven was readmitted to Eagleville Sanatorium on January 15, 1945. Roentgen examination showed an old fibroid infiltration in both upper lobes with a large cavity on the right. Sputum was highly positive. The patient was treated conservatively and in October, 1947, the cavity blocked. The patient improved rapidly. He gained 42 pounds. He was discharged on October 13, 1949. Sputum has remained negative.

CASE VI. R. L., male, aged sixty, was admitted to Eagleville Sanatorium on May 10, 1948. Sputum was highly positive. A roentgenogram revealed a large cavity about 4 cm. in

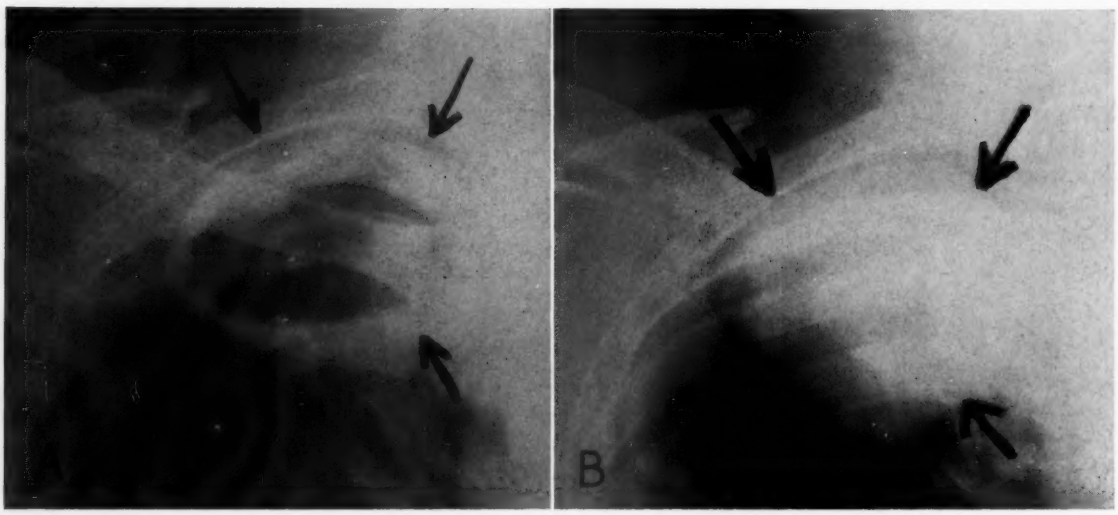

FIG. 5. Case V. (*A*) Shows a huge cavity in the apical segment of the right upper lobe, in January, 1945. (*B*) The same cavity after it blocked in October, 1947. The patient has gained 42 pounds in weight and has been well since.

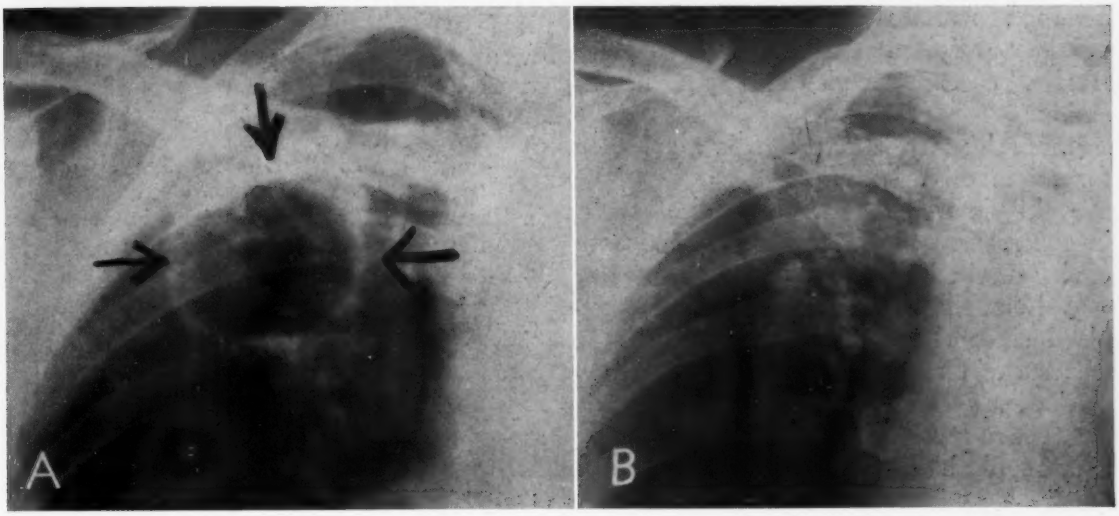

Fig. 6. Case vi. (*A*) Discloses a large cavity in the subapical segment of the right upper lobe in May, 1948. The cavity blocked in January, 1949. (*B*) Sputum has been negative since 1949 and the patient feels well.

diameter in the right upper lobe. The patient was treated conservatively and he improved quickly. On January 13, 1949, the cavity blocked and sputum remained negative since. He was discharged on January 30, 1949, having gained 20 pounds. He has been well since.

Case vii. C. S., female, aged forty-six, admitted on April 4, 1939, with cavity occupying the apical segment of the left upper lobe, and several small ones in the apical portions of the left lower lobe. Sputum was heavily positive. On conservative therapy the cavity on the left first grew larger and then blocked completely, and sputum turned negative, and has been consistently negative since January 6, 1943. The patient was discharged as "quiescent" on July 31, 1943, to continue her "cure" at home. She comes in for check-ups about twice a year, and the cavity has remained blocked and the sputum is still negative.

SUMMARY

1. No single mechanism can explain the method by which tuberculous cavities heal.

2. Such healing occurs in two general ways: (a) Open healing in which the cavity lumen becomes epithelialized. (b) Closed

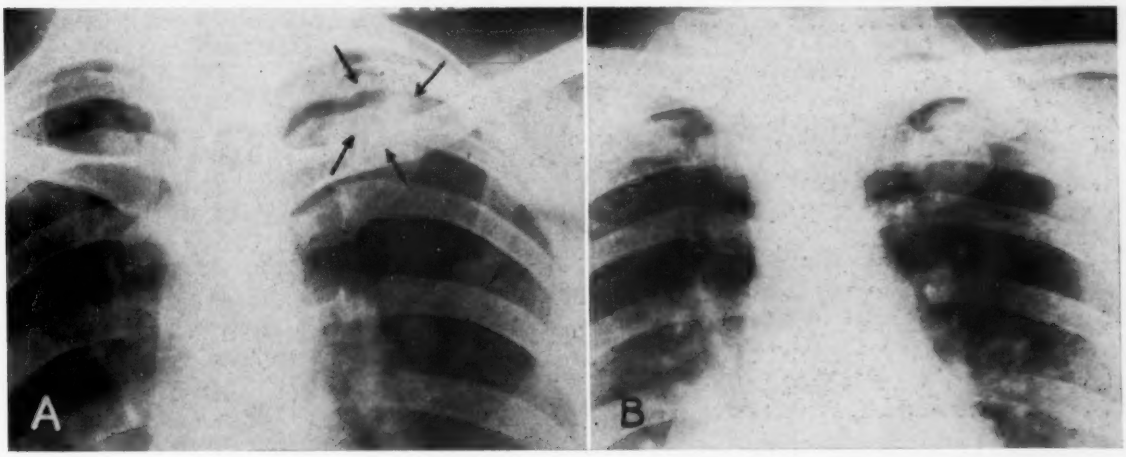

Fig. 7. Case vii. (*A*) Reveals a cavity in the apical segment of the left upper lobe in April, 1939. (*B*) Shows the cavity after it blocked. The patient has been well since 1943.

healing in which the cavity either becomes obliterated by scar tissue or is replaced by retained caseation which undergoes inspissation.

3. Healing by inspissation is a common form of inactivation.

4. Inspissated cavities are quite stable, in contrast to the intermittently blocking cavity or the balloon cavity.

5. Inspissated cavities can be recognized since they shrink in size with the passage of time, and they are not associated with systemic symptoms.

6. Since these lesions are stable in type, they should be treated conservatively.

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INVERSION OF THE STOMACH WITH EVENTRATION OF THE DIAPHRAGM

REPORT OF A CASE

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THE literature contains but few references to inversion of the stomach and in most instances eventration of the left diaphragm has been a concomitant finding.

Rhinehart and Rhinehart[5] reported in 1926 a case of inversion of the stomach without any anomaly of the diaphragm. Feldman[3] refers to inversion of the stomach only briefly and describes it as a rare finding which he encountered in only 2 instances in approximately 15,000 gastrointestinal examinations. Ekstrom[2] reported 2 cases of eventration of the diaphragm with inversion of the stomach, both occurring in fifty-five year old females who presented no gastrointestinal complaints. The combined anomalies were found in a twenty-four year old soldier by Rosenfeld[6] in 1944, who demonstrated further that in this case, as distinguished from previous ones, the pylorus and duodenal cap were situated in the left side of the abdomen. A case reported by Fichardt[4] in 1946 demonstrated essentially the same findings as described by Rosenfeld. Bockus[1] presents roentgenographic illustration of rotation and inversion of the stomach together with diaphragmatic hernia in a woman, aged seventy-four, and comments on the rarity of complete inversion of the stomach.

CASE REPORT

A. E., a male aged seventeen, enlisted in the Air Force on August 31, 1949. He had been entirely symptom free until 1948, when he seemed to notice moderate dyspnea on exertion. Prior to enlistment he had had no gastrointestinal symptoms. A chest roentgenogram had not been taken at any time prior to entry into the service. Shortly after reporting to Lackland Air Force Base for indoctrination training, the patient began to notice an intermittent "tightening feeling" in the abdomen, frequent nausea, and abdominal pain when lying on his left side or back. A routine photoroentgenogram was taken October 11, 1949, which revealed a high left diaphragm with the stomach bubble apparently visible at the level of the seventh rib. He was admitted to the Station Hospital for further study with a tentative diagnosis of diaphragmatic hernia.

Clinical and Laboratory Findings. No abnormalities were noted upon complete physical examination. The erythrocyte count was 4,810,000; hemoglobin 15.1 gm.; leukocyte count 6,750, with a normal differential picture; Kahn test negative; sedimentation rate 3 mm. (corrected) at one hour; urinalysis normal; vital capacity 3,500 cc. The electrocardiogram (Fig. 1 and 2) showed a PR interval of 0.08 to 0.10 second, normal QRS duration, moderately deep q waves in leads I and II, and no significant axis deviation or supporting evidence of nodal rhythm.

Roentgenographic Findings. In the chest film (Fig. 3) the following findings were observed: (1) shift of the cardiac mass and mediastinal structures to the right of the midline; (2) elevation of the left leaf of the diaphragm to the level of the inferior border of the seventh left rib posteriorly; and (3) a gas-containing structure, presumably stomach, underlying the elevated leaf of the diaphragm.

Upon roentgenoscopy of the upper gastrointestinal tract with the aid of barium (Fig. 4–9), the esophagus exhibited no abnormalities and was undisturbed by the elevated leaf of the diaphragm. The barium was observed to course anteriorly and inferiorly into the first portion of the stomach through the normal esophageal hiatus. From this point the barium traversed the gastric lumen in an inverted U fashion, posteriorly to anteriorly, producing a cascade effect, and the greater curvature of the stomach was observed to be immediately beneath the inferior surface of the eventrated diaphragm. The pyloric portion of the stomach and the

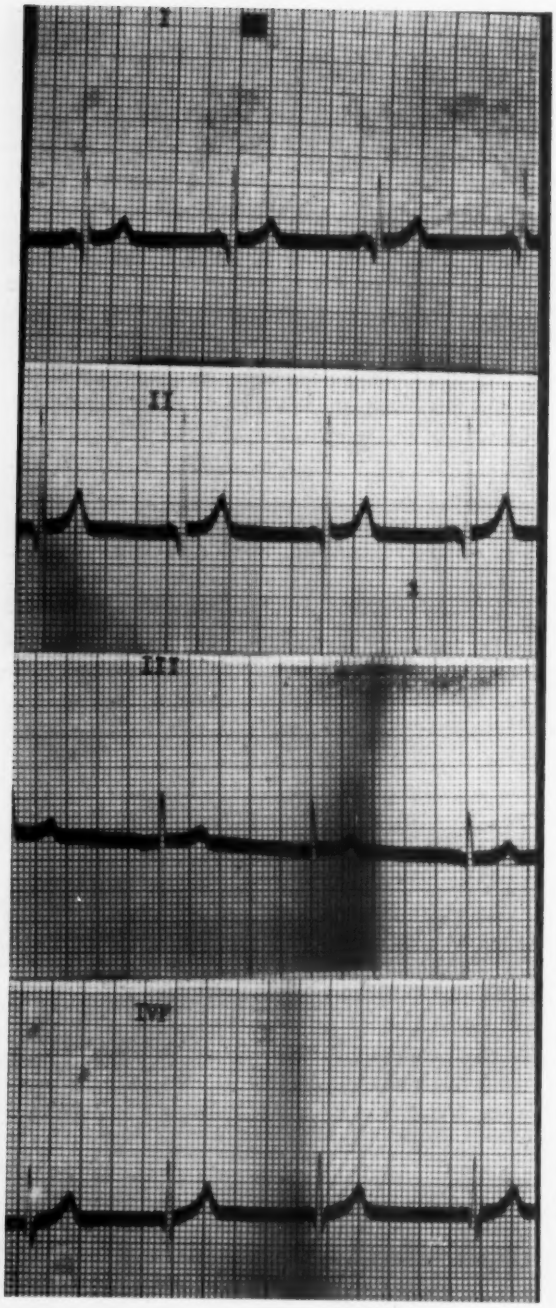

FIG. 1. Electrocardiogram, leads I, II, III, and IVF in a case of inversion of the stomach and eventration of the left diaphragm.

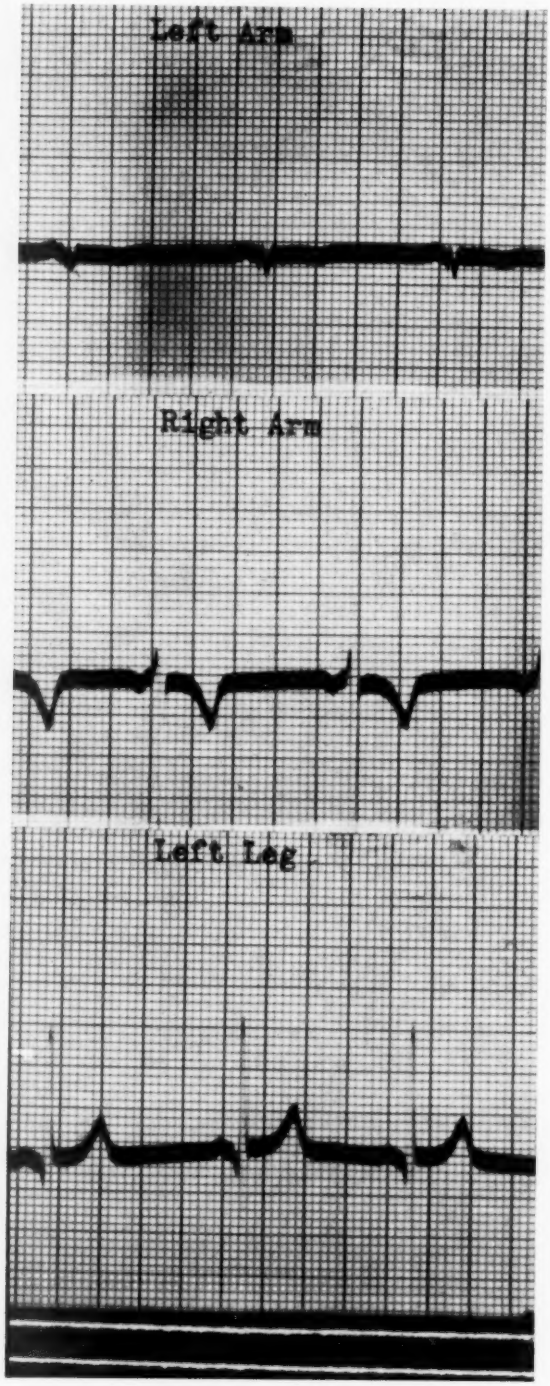

FIG. 2. Electrocardiogram with unipolar extremity leads.

pylorus were identified at the level of the tenth thoracic vertebra to the left of the midline. By virtue of approximately 90° rotation of that portion of the intestine, the anterior surface of the pylorus was in the sagittal plane when visualized in the right lateral position.

Peristalsis was normal throughout all segments of the intestine, with a normal locus of origin. The dependent portions of the cardia and pylorus were emptied of barium at the time

of the six hour film. The mucosal pattern was normal throughout, with no evidence of polyps, diverticula or ulcer.

Barium enema studies (Fig. 10) showed the sigmoid flexure of the colon displaced superiorly and located immediately beneath the elevated left diaphragm, predominantly to the left of the stomach. The colon exhibited a normal pattern in its entirety.

None of the examinations disclosed findings

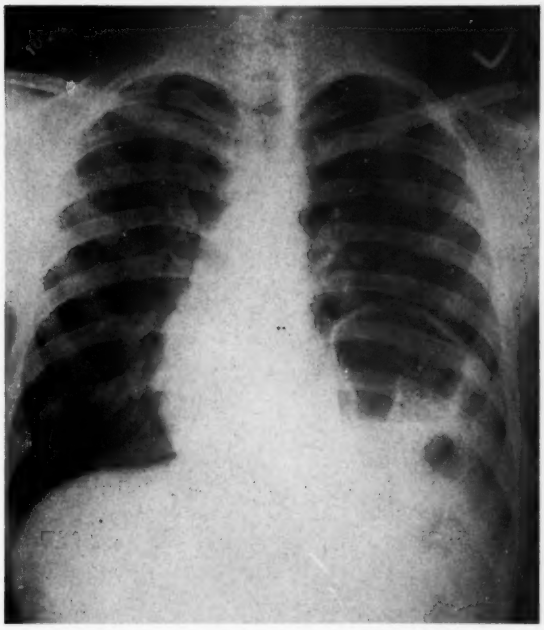

Fig. 3. Posteroanterior roentgenogram of chest. Shift of the cardiac mass and mediastinal structures to the right of the midline. Elevation of the left leaf of the diaphragm to the inferior border of the seventh left rib posteriorly. The gas-containing stomach and colon underlying the elevated leaf of the diaphragm.

compatible with hiatal, esophageal, or paraesophageal hernia.

Clinical Course. During the early part of the patient's hospitalization, he became acutely conscious of his stomach and was subject to intermittent abdominal pain and nausea, which we later had reason to believe were on an iatrogenic basis. After considerable reassurance he ceased worrying about his congenital anomalies and had no further pain or nausea.

Fig. 4. Barium swallow left lateral film shows the outline of the left leaf of the diaphragm. The esophagus is in its normal course and undisturbed by the elevated leaf of the diaphragm.

Fig. 5. Posteroanterior view. The pylorus is left of midline. The course of the duodenum is normal.

FIG. 6. Left lateral film. The stomach is inverted. The gastric flow tract is in the sagittal plane. The cardia is posterior. The pylorus is anterior. The stomach is cascade in type.

FIG. 7. Right oblique film. The well demonstrated outline of the left leaf of diaphragm is shown. The stomach is inverted.

CONCLUSION

The roentgenographic findings described in this case are characteristic of inversion of the stomach and eventration of the left diaphragm. The pylorus was visualized to the left of the midline, and in that regard the findings are similar to those reported by Rosenfeld and by Fichardt. The patient also demonstrates an elevated splenic flexure of the colon, such as one might expect in the presence of the other anomalies described. Interestingly enough, the

FIG. 8. Left oblique film. The eventrated left leaf of the diaphragm is well outlined. The stomach is inverted.

Fig. 9. Left lateral film. The stomach is inverted. The gastric flow tract is in the sagittal plane. The cardia is posterior. The pylorus is anterior. The stomach is cascade in type.

Fig. 10. Barium enema. The sigmoid flexure of the colon is displaced superiorly and located immediately beneath the elevated left diaphragm, predominantly to the left of the stomach.

anomalies in this case were unaccompanied by gastrointestinal symptoms until the patient was made aware of his condition, and at the present time he is entirely asymptomatic.

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THE DETECTION OF GASTRIC CARCINOMA BY PHOTOFLUOROGRAPHIC METHODS*†

PART III. FINDINGS

By JOHN F. ROACH, ROBERT D. SLOAN, *and* RUSSELL H. MORGAN

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I. INTRODUCTION

IN JANUARY, 1948, a project was started at The Johns Hopkins Hospital in which photofluorographic gastrointestinal examinations were performed on all new dispensary patients forty years of age or above. In the subsequent twenty-nine months a total of 10,000 such photofluorographic studies have been performed, and an analysis of the data obtained from these studies is herein presented.

The indications for this study and the equipment used have been discussed in Parts I and II of this series.[1,2] In brief, it has been estimated that approximately 40,000 individuals above the age of forty develop malignancy of the stomach each year in the United States. The outlook for these patients is distressingly poor, the average length of life following the recognition of the disease being of the order of one year and eight months. To date the only form of therapy which offers any hope of cure in gastric malignancy consists of surgical excision of the tumor tissue. By the time patients develop sufficient symptoms to force them to seek medical advice, however, surgical cure is not feasible in a large percentage of the cases. If anything is to be done to reduce the death rate from gastric malignancy, when present methods of therapy are used, it seems obvious that it must come through some method by which the diagnosis may be made before the tumor has extended beyond the scope of the surgical excision. Practically, this means that in most cases the diagnosis must be made prior to the development of significant symptoms. It also means that large groups of asymptomatic individuals in the appropriate age group must be examined, and that the diagnostic procedure used must be applicable to mass survey needs.

At the present time, the roentgenological method constitutes the most reliable diagnostic procedure at our disposal for the examination of the stomach. Conventional fluoroscopy and roentgenography, however, are not easily adaptable to mass survey needs. The former requires the presence of a trained radiologist at all times, with the ever-present danger of excessive radiation to the fluoroscopist. Conventional filming is too expensive, both from the viewpoint of the initial cost of the film and the problem of storing the large number of films which would rapidly accumulate. Photofluorography, on the other hand, has none of these objections. The presence of a fluoroscopist is not required and the examination can be rapidly and easily executed by a technician. The cost of the film is not excessive, and its storage offers no real problem. The chief objection to photofluorography has centered around the excessive radiation to which the patient must be subjected when multiple exposures are made during a gastrointestinal examination. This objection has been overcome by the application of Schmidt optics to photofluorographic camera equipment. With cameras of the Schmidt type it is possible to take photofluorograms of the abdomen with little more exposure than that used in conventional roentgenography. The apparatus which we have used in this study consists of a standard 200 milliampere

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generator operating at 95 kv. (peak) and controlled by a photoelectric automatic timer, a rotating anode tube, and a grid-screen-camera assembly using a Patterson type E-2 screen and a Schmidt-Helm camera. The grid-screen-camera assembly is mounted beneath a horizontal roentgenographic table to permit the examination of patients in the recumbent position, thereby assuring a completeness of study not attainable with other positions.

The technique used in conducting the examinations is relatively simple. All new dispensary patients who are forty years of age or above, regardless of their symptoms, are referred on their first visit to the photofluorographic unit. It has not been found necessary for the patients to undress, or to be fasting in the usual sense of the word. They are first given 2 ounces of a barium sulphate-water-chocolate malt mixture, and an anteroposterior and two right anterior oblique exposures are made. The patients are then asked to drink an additional 4 ounces of the opaque mixture, making 6 ounces in all, and a posteroanterior and two right anterior oblique exposures are made. Thus, each patient receives a total of six exposures, all of which are made in the recumbent position. A technician performs the entire examination which takes only four to five minutes. At the end of each day the exposed film strip is developed. The examinations are then studied, and a report of the findings is placed in each patient's history. If any pathology is seen on the miniature study the patient is asked to return for a conventional gastrointestinal series, so that the presence of a lesion can be confirmed, or ruled out.

At the onset of the study we hoped to answer three basic questions. First, is the photofluorographic method sufficiently accurate, when compared to the standard gastrointestinal examination, to make it a satisfactory method of detecting gastric pathology? Second, is it possible to detect enough early asymptomatic gastric cancers or their precursors to make the method of practical value in reducing the death rate from gastric malignancy? Third, is the technique of any value as a general survey method for detecting the presence or absence of pathology of all types involving the upper gastrointestinal tract?

II. FINDINGS

An analysis of the data obtained from the 10,000 photofluorographic gastrointestinal examinations is now presented. The age and sex distributions of the cases are shown in Tables I and II. The preponderance of female over male and white over colored merely represents the distribution of the dispensary population examined.

Table I

AGE DISTRIBUTION

Age	No. Cases	Per Cent
40–49	3,718	37.2
50–59	2,905	29.1
60–69	2,181	21.8
70–79	1,054	10.5
80–89	141	1.4
90–99	1	0.0
TOTAL	10,000	100.0

Table II

RACE AND SEX DISTRIBUTION

Race and Sex	No. Cases	Per Cent
WM	2,973	29.7
CM	1,611	16.1
WF	3,417	34.2
CF	1,999	20.0
TOTAL	10,000	100.0

In 9,072 of the 10,000 photofluorographic studies, or 90.7 per cent, it was felt that the stomach was visualized sufficiently well to warrant a diagnostic interpretation. In the remaining 928 cases, or 9.3 per cent, the stomach was inadequately demonstrated. This information, and the reasons for the unsatisfactory studies, are presented in Tables III and IV. It will be seen that 5.3

TABLE III

DIAGNOSTIC STATUS OF THE PHOTOFLUOROGRAPHIC STUDIES

	No. Cases	Per Cent
Satisfactory studies	9,072	90.7
Unsatisfactory studies	928	9.3
TOTAL	10,000	100.0

per cent of all studies were unsatisfactory because of the presence of excessive food within the stomach. This figure seems relatively small, when it is recalled that no particular effort was made to have the patients in a true fasting state. The average fasting time of all of the patients was approximately three to four hours. In 3.5 per cent of all examinations, technical errors including mechanical defects within the equipment, processing difficulties, and faulty positioning of the patient upon the table rendered the studies unsatisfactory. In 0.5 per cent of the cases excessive obesity prevented the obtaining of satisfactory photofluorograms.

Table v shows the breakdown of the satisfactory miniature studies in regard to the interpreted status of the stomach and duodenal bulb. In 90.6 per cent, the stomach was interpreted as normal, while in 9.4 per cent, or 853 cases, the appearance of the stomach suggested the presence of pathology. The duodenal bulb was thought to be normal in 50.0 per cent and abnormal in 2.2 per cent of the studies. In 47.8 per cent of the examinations it was inadequately filled to warrant a diagnostic opinion.

TABLE IV

UNSATISFACTORY PHOTOFLUOROGRAPHIC STUDIES

Causes	No. Cases	Per Cent of Unsatisfactory Studies	Per Cent of All Studies
Food	528	56.9	5.3
Technical	345	34.2	3.5
Obesity	55	5.9	0.5
TOTAL	928	100.0	9.3

In the group of patients having satisfactory miniature studies there were 1,209 cases, or 13.3 per cent, who also received standard gastrointestinal series. Since it is the standard gastrointestinal examination against which the photofluorographic method must be compared, the majority of the data hereafter will be devoted to this group of cases. Before concentrating on this group, however, mention should be made of the 7,863 cases, or 86.7 per cent, in which the miniature studies were not checked by regular gastrointestinal series.

TABLE V

INTERPRETED STATUS OF STOMACH AND DUODENAL BULB IN SATISFACTORY MINIATURE STUDIES

Stomach	No. Cases	Per Cent Satisfactory Studies
Normal	8,219	90.6
Abnormal	853	9.4
TOTAL	9,072	100.0
Duodenal Bulb	**No. Cases**	**Per Cent Satisfactory Studies**
Normal	4,532	50.0
Abnormal	200	2.2
Inadequately visualized for diagnostic purposes	4,340	47.8
TOTAL	9,072	100.0

Of these, 7,462 were interpreted as having normal stomachs. The remaining 401 cases were thought to be abnormal. In slightly over half of the latter individuals, there was no question of a neoplasm or its precursor, the pathology being of a benign nature. There were, however, 185 cases in which the possibility of neoplastic disease could not be completely excluded from the appearance of the miniature studies. Reasonable efforts have been made to recall these individuals for regular gastrointestinal series, but so far they have been unsuccessful.

The correlation between the gastric find-

ings on the photofluorographic and standard gastrointestinal examination is shown in Table VI. It will be noted that in 60.6 per cent of the 1,209 cases the stomach was interpreted as normal on both the regular and the miniature studies. Many of the patients in this group had symptoms of varying degrees suggestive of gastrointestinal pathology. In 10.4 per cent of the cases the stomach was found to be abnormal on both studies. In 25.4 per cent the stomach was thought to be abnormal on the miniature study, only to have a standard gastrointestinal series reveal a normal stomach. This initially appears to be a high false positive error for the photofluorographic method, but it must be pointed out that the clinicians were more likely to send an asymptomatic patient with an abnormal miniature report back for the standard examination than they were to send one whose miniature study was reported showing a normal stomach. Also, it has been our policy to interpret any abnormality on the photofluorographic study, no matter how small, as being significant until proven otherwise. There were 17 cases in which the stomach was thought to be normal on the miniature study, only to have pathology detected on the conventional series. This would seem to be a relatively low false negative error. In 2.2 per cent of the patients who had both types of examinations, the standard gastrointestinal series was not entirely satisfactory for evaluation of the status of the stomach.

TABLE VI

CORRELATION BETWEEN GASTRIC FINDINGS OF REGULAR AND MINIATURE GASTROINTESTINAL SERIES

Stomach Interpreted as Being	No. Cases	Per Cent
Normal on both studies	732	60.6
Abnormal on both studies	126	10.4
Abnormal on miniature but normal on regular gastrointestinal series	307	25.4
Normal on miniature but abnormal on regular gastrointestinal series	17	1.4
Unsatisfactorily evaluated on regular gastrointestinal series	27	2.2
TOTAL	1,209	100.0

TABLE VII

CASES IN WHICH GASTRIC PATHOLOGY WAS DETECTED ON BOTH MINIATURE AND REGULAR STUDIES

	No. Cases
Proven gastric malignancy	27
Unproven but potential gastric malignancy	27
Malignancy suspected preoperatively but proven benign	20
Unproven but potentially benign lesion	52
TOTAL	126

In the group of cases in whom the presence of gastric pathology was detected on both the miniature and standard examinations there were 27 with proven gastric malignancy and 27 others in whom the presence of malignancy or its precursor is suspected but is as yet microscopically unproven. There were also 20 cases in whom malignancy was suspected preoperatively, but in whom the lesions were proven to be benign. Fifty-two additional cases presented unproven but potentially benign gastric lesions. This material is tabulated in Table VII.

In Table VIII the proven cases of gastric malignancy are analyzed in regard to their histopathology and symptomatology. Among these 27 cases there were 23 carcinomas, 2 lymphosarcomas, and 2 sarcomas. It will be noted that the majority presented moderate to marked symptoms. The follow-up of this group to date conforms to the pattern noted previously for patients with symptomatic gastric neoplasms. At the time of surgery the neoplastic processes extended outside the confines of the stomach in 23 of the 27 cases, either in the form of metastases or by direct extension. In

TABLE VIII

PROVEN GASTRIC MALIGNANCY

Histopathology	No. Cases
Adenocarcinoma	16
Undifferentiated carcinoma	6
Scirrhous carcinoma	1
Lymphosarcoma	2
Neurogenic sarcoma	1
Spindle cell sarcoma	1
TOTAL	27

Symptoms	No. Cases
Absent	1
Minimal	4
Moderate to marked	22
TOTAL	27

12 cases operative removal was out of the question, and only biopsy or palliative surgery was undertaken. In the remaining 15 cases surgical resections were attempted. Of the 27 cases, 11 are known to be dead.

The race and sex distributions of the proven gastric malignancies are of some interest. Sixteen of the patients were colored males, 4 colored females, 5 white males, and 2 white females. The proportion of colored to white seems considerably greater than expected, although the group is probably not large enough from which to draw any statistical conclusions.

In most of these patients the clinical diagnosis of gastric neoplasm would have been made without the benefit of the photofluorographic examination, although in several instances the correct diagnosis was made more quickly because of the miniature studies.

A tabulation of those cases in whom the stomach was abnormal on both the miniature and standard examinations, and in whom the presence of malignancy is suspected but as yet unproven, is presented in Table IX.

It is quite probable that some of these cases have benign gastric lesions, but from the roentgen appearance malignancy cannot be excluded. The 10 cases in whom the antra presented narrowed and irregular appearances are of interest. Most of these patients have had several regular gastrointestinal studies, and roentgenologically it has been impossible to reach definite conclusions regarding the significance of the findings. In 21 of the 27 cases symptoms are absent or minimal. It is this factor which chiefly explains why we as yet have no microscopic proof concerning the nature of the gastric pathology present. It has been impossible to convince the majority of the individuals that they have lesions serious enough to warrant their entering the hospital for exploratory laparotomies. In a few of the cases, surgery has been avoided because of extenuating circumstances; in some, the life expectancy seems short due to the presence of other pathology, and in others the risk of a laparotomy has appeared unduly great. To date 4 patients in this group have died, but unfortunately autopsies were not obtained.

The 20 cases in whom gastric malignancies were suspected preoperatively, but in whom benign lesions were eventually found, are presented in Table X. In this group there were 12 cases with benign ulcers. Four individuals with benign neoplasms were also encountered, including 2 cases of

TABLE IX

UNPROVEN BUT POTENTIAL GASTRIC MALIGNANCY

Roentgen Appearance of Lesions	No. Cases
Polyp or polypoid-like filling defect	10
Ulcerating lesion	4
Infiltrating lesion	3
Narrower and irregular antrum of undetermined significance	10
TOTAL	27

Symptoms	No. Cases
Absent	17
Minimal	4
Moderate to marked	6
TOTAL	27

polyps (multiple polyps being present in 1), 1 with a leiomyoma and 1 with a neurofibroma. Of the remaining 4 cases there were 2 in whom the antra were deformed by extrinsic adhesions; 1 case had a bizarre gastritis of the cardia and fundus, possibly on a syphilitic basis, and at surgery 1 case presented an antral deformity secondary to hypertrophied rugal folds.

TABLE X

MALIGNANCY SUSPECTED PREOPERATIVELY BUT PROVEN BENIGN GASTRIC LESIONS

	No. Cases
Benign gastric ulcer	12
Benign gastric neoplasm	4
Other	4
TOTAL	20

Table XI presents those cases with unproven but potentially benign gastric lesions which were detected on both the regular and miniature examinations. In the 5 probably benign ulcers, the lesions have been followed for a significant length of time, with complete healing of the crater in most of the cases, so that malignancy seems highly improbable. The remaining cases are self explanatory, except for the "Other" group, in whom there were prominent gastric rugal folds of questionable significance.

It is of some interest to analyze the group of cases in whom the presence of gastric lesions was suspected on the miniature studies, only to have the standard gastrointestinal series reveal the presence of a normal stomach. Table XII reveals the location of the suspected lesions, and their roentgenographic appearances on the miniature studies. In 73.7 per cent the suspected lesions were in the antra and pylorus. The bodies were thought to be abnormal in 15.6 per cent and the cardiae and fundi in 10.7 per cent. In 76.7 per cent of the cases the roentgenologic patterns indicated narrowed or irregular lumens, the antra being the chief sites of involvement.

TABLE XI

UNPROVEN BUT POTENTIALLY BENIGN GASTRIC LESIONS

	No. Cases
Hiatus hernia	29
Postoperative stomach	6
Gastric diverticula	6
Probable benign ulcer	5
Extrinsic pressure defect	3
Other	3
TOTAL	52

Spasm, irritability, and prominent rugal folds frequently caused the abnormal appearances. In many of these cases the standard series revealed the same appearance, but after careful study it was felt that significant organic lesions were not present. The filling defects and suspected pyloric obstructions probably represent residual food within the stomach. The suspected ulcer craters may have been caused by superimposition of small intestinal loops over the stomach, while the suspected

TABLE XII

STOMACH INTERPRETED AS ABNORMAL ON MINIATURE BUT NORMAL ON REGULAR GASTROINTESTINAL SERIES

Location of Suspected Lesion	No. Cases	Per Cent
Antrum and pylorus	226	73.7
Body	48	15.6
Cardia and fundus	33	10.7
TOTAL	307	100.0

Roentgen Appearance of Suspected Lesion	No. Cases	Per Cent
Narrowing or irregularity of lumen	236	76.9
Filling defect	44	14.3
Ulcer crater	11	3.6
Pyloric obstruction	8	2.6
Hiatus hernia	4	1.3
Other	4	1.3
TOTAL	307	100.0

TABLE XIII

STOMACH INTERPRETED AS NORMAL ON MINIATURE BUT GASTRIC PATHOLOGY DETECTED ON REGULAR GASTROINTESTINAL SERIES

	No. Cases
Proven gastric malignancy	2
Unproven but potential gastric malignancy	3
Proven benign lesion	3
Unproven but potential benign lesion	9
TOTAL	17

hiatus hernias were likely due to prominent phrenic ampullas or intermittent hiatus hernias which were not demonstrated at the time of the standard study.

Of considerable importance are the 17 cases in whom the miniature studies were interpreted as normal, only to have gastric pathology detected on standard gastrointestinal series. These cases are tabulated in Table XIII. There were 2 cases of proven gastric malignancy in this group. The standard studies were done six and nine months respectively after the miniature examinations, and in both instances the lesions were proven to be inoperable carcinomas. There were 3 cases of unproven but potential gastric malignancy. In 1 of these the standard and miniature studies were done the same month, and the regular examination revealed a gross nodular lesion in the upper portion of the body of the stomach. To date this patient has refused surgery. In the second case the standard study was performed seven months after the miniature, and a questionable lesion of the cardia was detected. This patient died of pulmonary fibrosis and cardiac failure, and no autopsy was obtained. In the remaining case the miniature study was interpreted as showing an extrinsic pressure defect upon the body of the stomach in this area. Clinically this patient was thought to have an inoperable carcinoma. and was discharged without surgical confirmation. The 3 proven benign gastric lesions included one benign gastric ulcer, one small polyp of the antrum, and a rather bizarre polypoid lesion of the antrum, diagnosed by the pathologists as localized urticaria. In the entire group, the miniature and standard examinations were performed within a month or so of each other. The 9 cases in whom unproven but potentially benign gastric lesions were not detected on the miniature studies included 4 hiatus hernias, 2 gastroenterostomies, 2 probably benign ulcers and 1 case with prominent rugal folds along the greater curvature of the body.

III. DISCUSSION AND SUMMARY

In the twenty-nine months subsequent to January, 1948, a total of 10,000 photofluorographic gastrointestinal examinations have been performed at The Johns Hopkins Hospital on dispensary patients forty years of age or over. The reasons for undertaking the study, the equipment design, and the manner of conducting the examinations are briefly reviewed. The findings of the 10,000 studies are presented and discussed. From these data, partial answers, at least, can be given to the three basic questions which concerned us at the onset of the study.

First, is the photofluorographic method sufficiently accurate, when compared to the standard gastrointestinal examination, to make it a satisfactory method for detecting gastric pathology? It is felt that the method is sufficiently accurate. Of the miniature studies, 90.7 per cent were satisfactory for diagnostic interpretation. Of these, 1,209 cases, or 13,3 per cent, had standard gastrointestinal series in addition to the miniature studies. In this group there were only 17 cases in whom the miniature studies were interpreted as showing a normal stomach, only to have the standard examination reveal the presence of gastric pathology. The false positives were 25.4 per cent. These represent the cases in whom the photofluorographic study suggested gastric pathology, but in whom the regular gastrointestinal series revealed a normal stomach. This appears to be an excessively high

error, but as pointed out previously these patients were much more likely to receive the standard series than were those in whom the miniature study was reported as showing a normal stomach. If one includes all of the satisfactory miniature studies, the false positive error falls to 3.3 per cent, and this is felt to be a more accurate estimate of the situation. It is obvious, however, that any apparent abnormality on the miniature study should be checked with a standard gastrointestinal study before a definite opinion is reached regarding the status of the stomach.

The second question dealt with the possibility of detecting a sufficient number of asymptomatic gastric cancers or their precursors to make the photofluorographic method of practical value in reducing the death rate from gastric malignancy. Here a definite failure must be reported. The number of individuals with early neoplastic disease is relatively small, being approximately 1 per 476 examinations, or 0.2 per cent in our series; furthermore, it has been our experience that only a few of these can be persuaded to submit themselves to surgery prior to the development of symptoms. It appears that the general public must receive further education concerning the gastric cancer problem before photofluorography will be successful. It will be of interest to follow the asymptomatic cases, however, since through them we may gain information concerning the life history of gsatric malignancy.

The third and final question dealt with the problem of whether or not the technique would be of any value as a general survey method for detecting the presence or absence of other types of pathology of the upper gastrointestinal tract. Here the answer is somewhat more favorable. The true incidence of gastric pathology in the series is difficult to evaluate. If one takes only those cases in whom lesions detected by the miniature studies were actually confirmed by standard examinations the over-all incidence is 1.3 per cent, or 1 per 79 examinations. The true figure, however, is probably somewhat greater than this. The chief drawback to the photofluorographic method for general mass survey use centers around the considerable number of cases in which the duodenal bulb is inadequately visualized for diagnostic purposes. This was found to occur in 47.8 per cent of the cases in our series. Currently efforts are being made to reduce this figure by prolonging the interval between the taking of the opaque medium and the filming process. It is our feeling that the photofluorographic method will be of value as a survey method in large institutions, where considerable numbers of gastrointestinal examinations are requested by the clinicians. With this method it should be possible to greatly reduce the number of standard examinations which are necessary, thus resulting in a considerable saving in time and expense to the clinician and patient.

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LEIOMYOSARCOMA OF THE STOMACH WITH EXCAVATION OF THE CENTER OF THE TUMOR*

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A REVIEW of the literature on non-epithelial tumors of the stomach indicates clearly that the leiomyosarcoma may grow into the gastric lumen and become pedunculated, may remain almost wholly within the layers of the gastric wall, or may grow outward and involve a relatively small portion of the wall of the stomach. It is indicated that the tumor has a tendency to be spherical, that it is frequently of large size, and that it commonly outgrows its blood supply so that there is necrosis in its central portion. The exogastric type evidently gives rise to few symptoms for long periods of time and thus permits its growth to large size before medical aid is sought and the diagnosis made.

FIG. 1. Case 1, showing the barium-filled, irregular cavity which lies within the lesser curvature of the stomach. There is almost no abnormality of contour or of mucosal pattern of the stomach.

The central ulceration of the endogastric tumors and the central necrosis of the exogastric tumors are referred to frequently. The ulceration of the endogastric tumors is histopathologically and gastroscopically different from benign gastric ulcer in that it usually is not lined by granulation tissue. It is instead lined by partially necrotic tumor tissue within which there is a moderate inflammatory infiltration of polymorphonuclear cells.[1] Balfour in discussing the paper of Rieneits[1] stated that the ulcer is sometimes deep enough to give a picture suggestive of diverticulum, but I have been unable to find reference to a specific case in which the necrosis within an exogastric tumor mass resulted in the formation of a cavity which communicated with the gastric lumen and was evident preoperatively. I wish to report 2 cases in which this series of events did occur. The formation of such a cavity and communication is undoubtedly rare even in leiomyosarcoma, but evidently does not occur in other types of gastric neoplasm. A correct, preoperative, histopathological diagnosis therefore seems possible and should be of value, since a knowledge of what is to be expected permits the surgeon to assess the situation more readily on opening the abdomen.

REPORT OF CASES

CASE 1. An unmarried female, aged fifty-three, was admitted to the hospital under the care of Dr. F. G. Brigham on December 13, 1942, for study of a secondary anemia. She had had a thrombophlebitis involving the right leg about three months before and had noted pallor during convalescence from this illness, but was otherwise free from symptoms. Physical examination was negative except for evidence

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of anemia and some swelling of the right leg. No masses were felt in the abdomen.

Laboratory examination showed a red blood cell count of 2,920,000 with 4.9 grams hemoglobin. Reticulocyte count was 2.2 per cent. White blood cell count was 8,900 with 68 per cent polymorphonuclears, 15 per cent lymphocytes, 9 per cent monocytes, and 8 band forms per 100 cells. Smear showed polychromatophilia, anisocytosis, and poikilocytosis. Serum protein was 6.8 grams per cent with 3.5 grams albumin and 3.3 grams globulin. Gastric analysis showed no free acid in the fasting specimen with a high value of 38 per cent free hydrochloric acid after an Ewald meal; all specimens showed a positive benzidine test for blood. Stools also showed a positive test for occult blood.

Roentgen examinations of the chest and colon showed no evident abnormality. Examination with barium by mouth showed normal position of the stomach whose contours also appeared normal except for a small area on the lesser curvature about 3 cm. below the cardiac orifice. Within this area, there was a smooth-walled 4 by 7 mm. channel through which the gastric lumen communicated with an irregular cavity which measured about 7 by 11 cm. The gross irregularity of this cavity was very suggestive of a malignant tumor and yet all portions of the gastric contour which could be palpated seemed flexible and showed normal peristaltic waves. The stomach itself was empty at six hours, but there was residual barium in the cavity which lay within its lesser curvature. It was readily apparent that we were dealing with some unusual condition but we were not then aware of such extensive excavation within a leiomyosarcoma and presumed that the findings were due to carcinoma within a diverticulum.

Several transfusions were given and the patient was operated upon on January 4, 1943, by Dr. L. S. McKittrick. A tumor which measured about 12 cm. in diameter was readily found and lay within the lesser curve of the stomach but was adherent to it only in a very small area just below the cardiac orifice. Excision of the mass with a small portion of the adjacent stomach wall was carried out after an opening into the stomach had shown no evident abnormality except in the small area of attachment. Convalescence was complicated by wound infection and parotitis but the patient

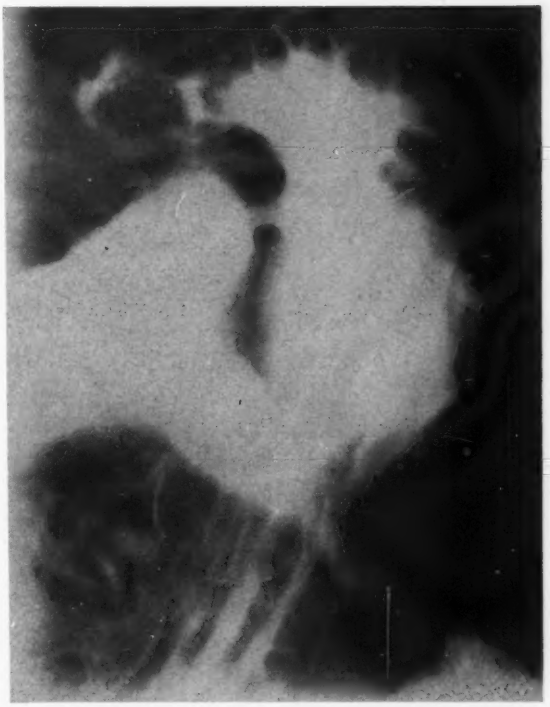

Fig. 2. Case I. Spot film showing the channel between the gastric lumen and the irregular cavity.

was gaining weight at the time of discharge from the hospital on the forty-ninth postoperative day.

The patient was then well until 1946 when the anemia recurred. In September of that year a total gastrectomy was done by Dr. R. H. Sweet because of recurrence of the tumor in the posterior wall of the stomach. She died on the fourth postoperative day from pulmonary embolism.

Case II. A male, aged fifty, was admitted to the hospital under the care of Dr. L. S. McKittrick on April 18, 1946, because of abdominal pain. This pain had come on suddenly while he was bowling five weeks before. It started on the left side of the abdomen but had spread toward the right and upward toward the shoulders. It was so severe that he was doubled up and had to be carried to his home. On the following day, his local physician noted a 10 cm. area of black and blue discoloration about the umbilicus. The pain gradually subsided but the patient had not felt well enough to return to work, and had spent most of the intervening time in bed. He stated that he had been afraid to eat more than very small amounts of food for fear that the pain might return and he had

FIG. 3. Case II. Roentgenogram showing the slight irregularity of contour and of mucosal pattern along the middle third of the lesser curvature.

lost about 20 pounds in weight. He had had no nausea or vomiting and had noted no discoloration of his stools. Physical examination at the time of admission to the hospital revealed no discrete masses but there was some fullness and a generalized sense of resistance in the upper abdomen.

Laboratory examinations revealed 4,810,000 red blood cells per cu. mm. with 12.6 grams hemoglobin. The white blood cell count was 6,800 with a normal smear. Urine was negative but all stools showed a strongly positive test for occult blood. Temperature ranged between normal and 100° F., with normal pulse and respiratory rates.

Roentgen examination of the stomach showed anterior displacement but a smooth contour. The mucosal pattern appeared normal in the proximal and distal thirds but showed question-

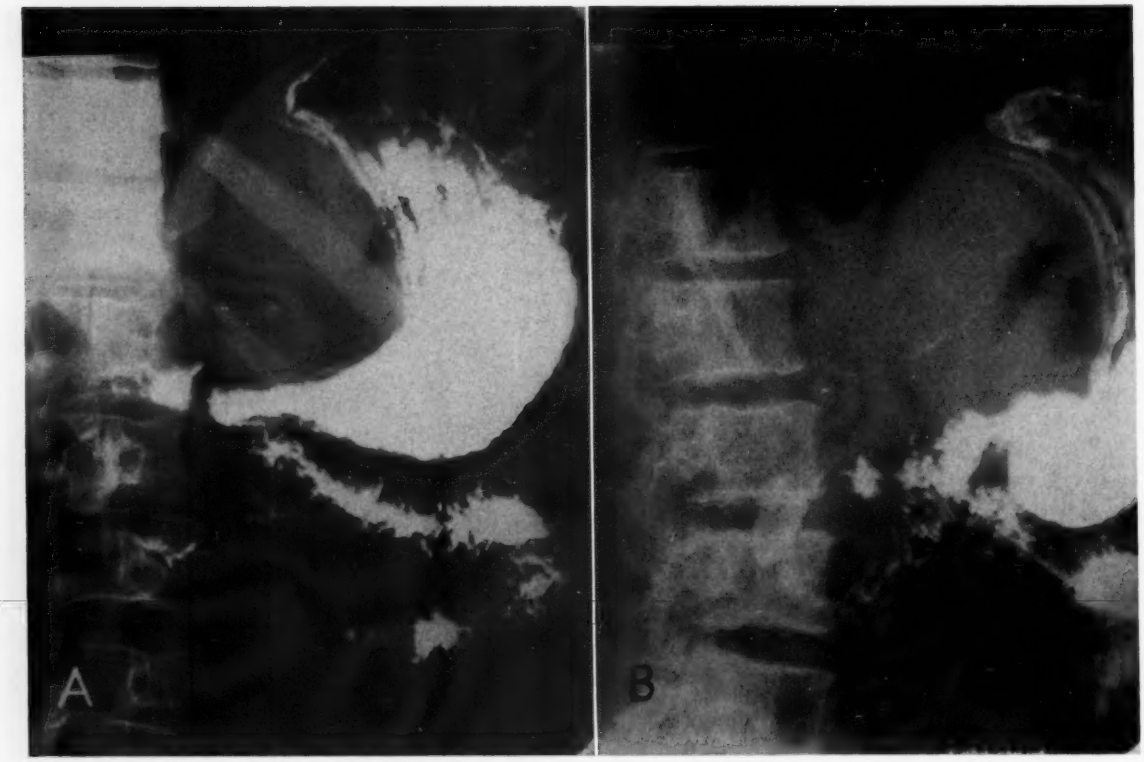

FIG. 4. Case II. Oblique (*A*) and lateral (*B*) films showing the irregular collections of gas behind the stomach. The lateral film also shows the anterior displacement of the stomach.

able irregularity and thickening of the folds in the middle third near the lesser curvature. No ulcer could be demonstrated in the stomach or duodenum, but there was a collection of gas bubbles just behind the lesser curvature of the stomach. These were at the level of the slight irregularity in the mucosal pattern and did not extend up to the diaphragm which was smooth in contour and normally placed. They were present on each of three successive days, but a fluid level was not demonstrated in relation to them and barium did not enter this region. Examination of the chest and colon was negative. It was evident that there was a retrogastric mass and that there was gas within this mass, but there was no clinical or roentgen evidence of perforated ulcer with abscess formation. The gas bubbles, therefore, seemed to indicate a communication with some part of the gastrointestinal tract although this communication had not been demonstrated by leakage of barium. Since we were now aware of the possibility of necrosis and excavation of an exogastric leiomyosarcoma, and the possibility of communication between the gastric lumen and the cavity within the tumor mass, a diagnosis of leiomyosarcoma was made.

This diagnosis was confirmed by histopathological examination of tissue removed at subsequent exploratory laparotomy although it was not possible to remove the tumor. The patient was discharged to his home after about three weeks in the hospital.

SUMMARY

Two cases of leiomyosarcoma of the stomach have been presented. The tumor masses lay almost entirely outside the stomach and were necrotic in their centers. The cavity produced by the necrosis communicated with the gastric lumen.

It is believed that the roentgen findings are pathognomonic of this tumor and that the correct histopathological diagnosis is therefore possible before operation.

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A ROENTGENOGRAPHIC STUDY OF SYNOVIOMA*

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SYNOVIOMA is an uncommon, highly specialized form of malignant tumor which takes its origin from the synovial lining of joints, bursae and tendon sheaths. There are many synonyms for this new growth including such terms as synovial sarcoma, synoviolosarcoma, synovioloma and synovial fibrosarcoma. Since the commonly used designation is synovioma, we shall continue to employ it here.

The report of such a tumor was made by Langenbeck[13] in 1865. A more detailed description of its clinical and pathological features was published in 1910 by Lejars and Rubens-Duval.[14] In 1927 Smith[18] introduced the term synovioma to designate this specific type of new growth. Later studies by Knox,[11] Haagensen and Stout[8] and Bennett[2] continued to use this term. The largest series of synoviomas have been 32 cases reported by Bennett, 16 cases of De Santo *et al.*,[6] 15 cases of Coley and Pierson,[5] and 104 cases of Haagensen and Stout (95 reviewed and 9 of their own). Recently Pack and Ariel[17] have presented the largest personal series totaling 60 cases. These authors, as well as others,[3,4,7,9,10] have emphasized either the pathological or clinical aspects, omitting any detailed study of the roentgen appearance of this tumor. In fact, only a few articles dealing primarily with the roentgen diagnosis of synovioma have been written, and these have usually been based upon relatively few cases.[1,12,15,16] Since our experience in the roentgen recognition of synovioma tended to be somewhat at variance with the ideas expressed in some of these studies, we have attempted a critical roentgenographic survey of 32 proved synoviomas in order to establish criteria for the roentgen recognition of this tumor.

Synovioma occurs as a single tumor showing almost invariably an intimate relationship to one of the joints. Upon gross examination it appears sharply circumscribed as if encapsulated. Frequently the tumor is firmly attached to adjacent tissues at one or more points, any one of which may represent either the site of origin of the tumor or an area of extension by invasion. On cross section, synovioma may be either firm, moderately fibrous or perhaps more frequently soft, spongy and friable. It may be lobulated or occasionally cystic, containing a clear fluid. The color may be yellow, indicating necrosis, or brown or reddish indicating old or recent hemorrhage. At times calcification may be encountered. Seldom is the entire tumor found within the cavity of the joint. Histopathologically synovioma shows a highly variable, complex mixture of two cellular components, one villous which is derived from the synovial lining, and the other connective tissue which often forms a sarcomatous pattern obscuring either partially or completely the first mentioned structure.

From 1931 to 1949, approximately 70 cases classified as synovioma have been seen at the Memorial Hospital. Since in this study interest is limited to the roentgen appearance of these tumors, only about half of the 70 have been found suitable for the present discussion. In 21 no roentgen studies were carried out. The roentgenograms in an additional 14 were either not available or they were of too limited extent or too poor quality to be of value. One or two proved synoviomas were eliminated because no tumor could be seen on the roentgenograms due to recent excision. Occasionally a tumor was not included for special reasons. For instance, one tumor with adequate roentgenograms had to be excluded because concurrent infection made it impossible to distinguish roentgenographically between the effects caused

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by the tumor and those due to the infection. In spite of such limitations and omissions, we believe that the 32 cases composing the material for this study represent an adequate sampling. All these tumors were diagnosed in the Pathological Laboratories of Memorial Hospital under Dr. James Ewing and Dr. Fred W. Stewart and the majority have recently been reviewed and confirmed by Dr. Stewart.

It is not the present object to deal with the clinical aspects of synovioma. However, as a background for the roentgen recognition of a tumor some mention of its important clinical features seems worth while. These patients ranged in age from ten to seventy years, nearly 80 per cent being between the ages of fifteen and forty-four. Most synoviomas were located about the knee, with 11 tumors so situated. Six synoviomas were found in the foot, 4 in the wrist, 4 in the hip, 3 in the hand, 2 in the shoulder, and 1 each in the ankle and elbow. Generally the symptoms were pain, swelling and disability, while the signs were tenderness, mass and limited motion. The initial complaints were painful swelling of the affected part in 2 cases, pain alone in 13 cases, and swelling alone in 17 cases. The primary lesion was solitary in all cases.

Of the total, only 9 patients were treated throughout their course at the Memorial Hospital. Treatment included such procedures as excision, amputation, disarticulation, and combined surgery and irradiation. Four of these patients are still living with no evidence of recurrence or metastasis. In these, the duration since the onset of the disease extended from five to twenty-two years. Most of the remaining 24 patients received repeated surgical or radiation treatment before admission to the hospital, and a few had additional treatment subsequent to hospital admission. Only 6 patients of this group are known to be living and well. The duration since the onset of disease varied from three and a half to fifteen years. In all, 23 of the 32 died. Among the dead the shortest duration of disease was ten months and the longest was seventeen years from onset of symptoms. Local recurrences after various forms of treatment were frequent. One case showed recurrence at the same site four times, 1 case three times, 5 cases twice and 11 cases once. The interval between the time of treatment and local recurrence varied from two months to seven years. Metastasis or direct extension of the growth to the neighboring tissues was found as early as the first year of the disease or as late as fifteen years after the onset of symptoms. Among the 23 dead cases, 17 had metastatic lesions in the lungs or pleura, many showed deposits in lymph nodes, and 2 had metastases in bones remote from the primary lesion.

Fig. 1. Synovioma located in popliteal region. This tumor displaces the artery posteriorly.

Each of the 32 patients had at least one satisfactory roentgen examination and many had interval film studies. This analysis of the roentgen appearance is based upon information taken from the initial film study with record being made of any additional information supplied by subsequent roentgenograms. At the onset this approach seemed to necessitate a division of the synoviomas into two groups.

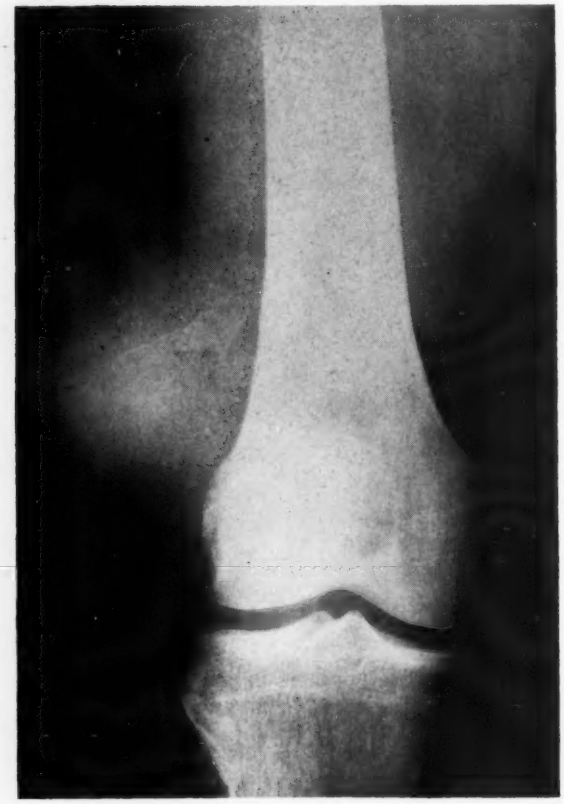

FIG. 2. Large synovioma of the right knee. The linear density represents adhesive dressing.

One comprised those tumors which were untreated or had merely a biopsy or "exploration" before the first available roentgen examination. There were 17 lesions in this category. The second group, numbering 15 tumors, had one or more attempts at excision or one or more series of irradiation or in a few instances a combined type of treatment before the first film examination that we were able to obtain. One could be sure in the first instance that the appearance reflected the original and uncomplicated tumor, but it was not until the analysis had been completed that it was also evident that the second group presented little essential difference from the first in spite of the previous manipulations that had been carried out. When in a few cases it did seem that a specific finding was related to the preceding treatment, this occurrence was indicated. In general, however, it was found feasible to consider all the tumors together, both the untreated and the recurrent, for the purpose of studying roentgenographic characteristics.

The configuration of most of the tumors could be determined fairly dependably from the roentgenograms. There were 18 presenting a spherical shape and the rest were oval. In this respect there was no significant difference between the untreated and the treated tumors.

All tumors were single except for one instance of a double recurrence at the site of the original tumor.

The size of the tumors was determined as accurately as possible from the earliest roentgenograms in each case. The size was expressed as diameter since it was found that these lesions were essentially spherical in configuration. It is interesting to note that the size distribution was about the

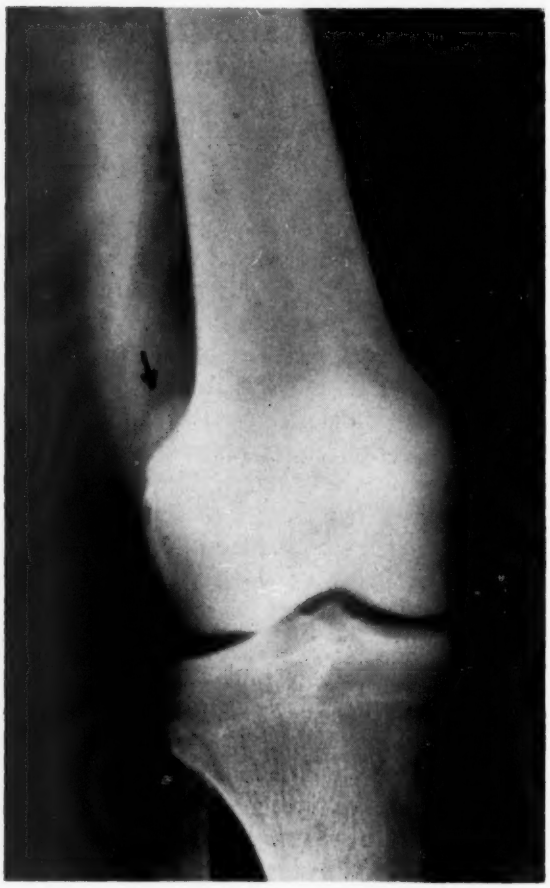

FIG. 3. Small synovioma with a distinct border.

same for the original untreated tumors and for the recurrent ones. In one patient no tumor was evident immediately following excision, but five months later a recurrence was detected. In another postoperative tumor two separate recurrences were demonstrated, one at each end of the original tumor area. Only the larger of these recurrences was considered in the following discussion. The smallest tumor of the series measured 2 cm. in diameter, and the largest, 16 cm. In the untreated tumors, there were 5 tumors 5 cm. or less in diameter; 7 tumors over 5 cm. and under 10 cm. in diameter; and 4 tumors with a diameter of 10 cm. or over. The 16 recurrent tumors showed 8 with a diameter of 5 cm. or less; 6 over 5 cm. and under 10 cm.; and 1 tumor over 10 cm. in diameter.

One of the most constant features of synovioma was its close association with a joint. In relating a tumor to a joint, particularly to the knee, the variability of capsular extensions must be taken into consideration. It was not always possible to tell from the films whether the tumor was located entirely within the capsular area or whether it was partially outside of this region. Nevertheless, it was always clear that the tumor mass as seen on the film was related to the capsule region in some degree. In other words, none of these synoviomas was sufficiently far from a joint to permit one to say that there could be no contact with the capsule. The intimate relationship to the joint is an important point in roentgen diagnosis.

Fig. 4. Synovioma located at the shoulder.

Fig. 5. Synovioma occurring in the posterior portion of the right ankle.

The presence or absence of effusion could be determined with assurance only as far as the knee was concerned, the roentgen diagnosis of effusion in other joints being based upon less reliable evidence. Altogether there were 11 synoviomas located at the knee. There were 2 cases where the position of the tumor precluded any statement about accompanying effusion. In the 9 where a judgment as to the presence or absence of effusion could be made, this condition was present once. There were 2 patients where the effusion suspected clinically could not be confirmed by the roentgen examination. A study of the operative records and the descriptions of the gross pathology also indicate the infrequency with which effusion is associated with synovioma.

FIG. 6. Synovioma of the elbow.

Another general type of response that may occur within the joint is a diffuse thickening of the lining membrane itself, such, for instance, as may be encountered in rheumatoid arthritis, villonodular synovitis or tuberculosis. At least as concerns the knee we have found no diffuse synovial thickening or nodularity as revealed roentgenographically. Neither have we evidence from the pathological reports or operative descriptions available in these cases that a diffuse reaction of the joint lining is to be expected in synovioma. The evidence indicates that synovioma exists as a solitary tumor unaccompanied by any general synovial reaction such as fluid, thickening or multiple nodule formation. One might consider that a nodular or diffuse synovial thickening would be more evident on roentgen examination with the use of pneumoarthrography. It has not seemed necessary to use this procedure although should there be film evidence of an intra-articular mass not verified clinically, then the procedure of injecting gas into the joint and taking a series of roentgenograms would seem to be indicated.

A narrow joint space reflecting cartilage loss was not identified in any of these cases. In one unusual synovioma there was obliteration of the joint space due to bone destruction by direct invasion but this is a special situation.

Osteoporosis was a not uncommon roentgen feature but it was never very pronounced. It was noted in 10 of the 33 cases. In most cases the demineralization seemed to be directly attributable to the position of the tumor rather than to the new growth itself. Three of the 10 cases showed bone destruction. Furthermore, there were 3 synoviomas located on the foot where use of the limb would be affected. Two more were in the wrist and 1 was in the hand where again there might be interference with the full use of the member. Most tumors were in a position where function of a limb would not be influenced appreciably and no demineralization was revealed.

Periosteal reaction was encountered once in association with bone destruction. Although there were a few additional tumors that showed bone destruction on the roentgenogram, this was the only instance of periosteal proliferation.

FIG. 7. Small synovioma of the right wrist.

The internal pattern of synovioma as revealed on the film was that of a homogeneous, structureless mass of water density. There were no dense areas suggesting septa, nor were there areas of relative radiolucence. The uniformity of the texture unbroken by any alteration seemed to be a rather constant feature and one considered useful in differential diagnosis from other soft tissue tumors. There were 3 tumors that had small areas of calcification within them, but being somewhat unusual they will be mentioned separately.

The tumors varied considerably in the ease with which they could be identified on the roentgenograms. This variation was influenced largely by whether a margin was seen projected into a more radiolucent zone such as the suprapatellar region, or whether the tumor had to be separated from a mass of surrounding muscle bundles. In studying the more ill-defined lesions, not only was the value of comparison with the normal side evident, but the need for excellent technique and multiple views was likewise emphasized. Equally important was a knowledge of the normal soft tissue anatomy of the various joints. While it was rare that the entire periphery of the lesion could be seen, comparison of the different positions usually made it possible to reconstruct the general outline. When the edge was clearly demonstrated, it was seen to be regular and smooth. There was no peripheral line of increased density such as might be cast by a denser capsule. What was visible, rather, was the termination of the homogeneous internal structure in an abrupt fashion with change into either a less dense or less homogeneous area. For the most part, there was little or no evi-

Fig. 9. Large synovioma demonstrating erosive type of bone destruction in the scapula. This tumor metastasized to the ilium.

Fig. 8. Synovioma of the finger at the proximal interphalangeal joint.

FIG. 10. Synovioma located in the foot showing several small calcific deposits.

dence of infiltration into neighboring structures except for the few cases where contiguous bone involvement took place.

Among the 32 synoviomas there were but 3 in which calcification could be identified on the roentgenograms and only 1 of these was an untreated tumor. In this synovioma, a 9 cm. (in diameter) tumor of the hip area, there were three 3 mm. calcific flecks. The 2 other tumors were both treated lesions, 1 being a recurrent tumor which had three previous operations and three previous courses of radiation therapy. This showed two 3 mm. calcific deposits. The last had no calcification on the initial roentgen examination but developed a 4 cm. mass of irregular calcification two years later. By this time the tumor was ulcerated and infected, and two courses of irradiation had been given. We consider calcification an infrequent finding in synovioma although others have been impressed by its occurrence.[15]

Bone destruction was likewise an uncommon finding in our material. There were 4 tumors presenting this finding and there was an additional case that probably had a very minute area of erosion at one edge of the tumor. After a period of three years another tumor developed an area of bone destruction where none was seen in the original study. Generally speaking, the amount of bone involvement was small when related to the size of the tumor itself. The edges of the bone destruction were finely ragged and somewhat ill defined, presenting no marginal sclerosis or thickening. The bone changes were therefore osteolytic, and in only 1 tumor was any productive change encountered when a few calcific shreds or flecks were identified within the area of bone destruction. In this group with bone changes a unique case must be mentioned which showed metastases to distant bones as well as demonstrating direct invasion.

Six of the tumors presented metastases in the lungs by the time of the first roentgenogram available for this study. All these occurred in recurrent tumors. One would expect, therefore, that at the time of the first visit to the physician metastases to the chest would ordinarily not be present.

To complete the study of roentgen characteristics of synovioma it seemed necessary to determine what effect passage of time had upon the appearance of the tumor as shown by growth changes. Similarly the effect of irradiation also required investigation. There were 11 synoviomas where interval film examinations were available for a study of these questions. The shortest period of coverage was two months and the longest was thirteen years.

There was only 1 tumor with an interval examination covering one year which had had no treatment and which therefore showed the effect of time alone. During this period we were unable to observe any

significant difference in appearance between the original films and the last, even to the extent that no evidence of growth had occurred.

Two special events occurring during the interval observation have been mentioned previously. These are the development of calcification over a period of two years in a tumor that had had irradiation and which was infected and ulcerated, and the appearance of a recurrence within five months following operation, the new tumor not being seen on the roentgenogram taken immediately after operation. This tumor also showed an accompanying increase in the amount of bone destruction present. No roentgen treatment had been given.

The tumor with a thirteen year observation merely showed a slight soft tissue deformity that could have been due to postoperative deformity or to a small recurrence. There was no evidence of recurrence clinically. Seven tumors were observed roentgenographically following irradiation for from two months to three years. Two seemed smaller after the treatments, 3 showed little or no effect, 1 revealed the development of bone erosion, and the last showed a slight increase in size.

Summary of Roentgen Findings. Roentgenographically synovioma is seen as a solitary, essentially spherical homogeneous mass of water density located at a joint. Its margins are regular, their ease of recognition depending largely upon the nature of the surrounding structures. Synoviomas average about 7 cm. in diameter and about one-third of all these tumors are found at the knee joint. Osteoporosis is fairly frequent. As determined roentgenographically, effusion, calcification, periosteal reaction, direct invasion, and bone destruction are uncommon, particularly in the early untreated tumor. Metastasis to the lungs is not expected in the early stages of synovioma. Synovioma will enlarge slowly with the passage of time, and, through the effects of irradiation, changes in size and occasionally changes in internal pattern may occur.

The roentgen reports made on these tumors were analyzed in order to gain insight into the problem of differential diagnosis. The roentgen diagnoses were made over a period of years and by different observers of varying degrees of experience. Furthermore, it was impossible to tell just how often a tissue diagnosis had been established previous to the roentgen study. Apparently, however, this did not occur very frequently because only 1 lesion was called synovioma, with 2 more said to be consistent with this tumor. Another was reported as soft tissue sarcoma, 7 as soft tissue mass, 1 as soft tissue swelling, 1 as a diffuse soft tissue shadow, and 3 as soft tissue alterations. Therefore, some abnormality was reported in 19 cases and in the majority the diagnosis of tumor was suggested.

In 1 case a completely negative statement was made and in 12 no mention was made of the soft tissue structures. Thus, in 13 cases a serious error of omission was made, since the present restudy of the same films established the presence of abnormality in each instance. Nearly all these erroneous reports are traceable to a specific period in the diagnostic department. These results would seem to indicate that an important error can be one of omission and oversight, and it would also seem that this could be rather easily corrected by a better knowledge of the roentgen anatomy of the joints and a deeper appreciation of the need for a close survey of the soft parts. It is doubtful if any clinically recognizable synovial tumor should escape the notice of the roentgenologist. One must again point out the value of good technique and the need at times for comparison with the normal side as well as the use of special studies in certain situations.

Once an abnormal soft tissue change was detected, it seemed to be diagnosable as a tumor since nearly all of the 19 cases were described in a manner quite consistent with such a lesion. It would thus appear that the eessntial problem in differential diagnosis is one of deciding what tumor is represented. It is worthy of note that none of

these synoviomas resembled a bone tumor, nor were any so diagnosed roentgenographically.

Perhaps it might seem to be too much to expect that one could suggest the nature of a soft tissue tumor from the roentgen examination. In order to put this to the test the roentgen appearance of 28 various soft tissue tumors was studied. It was readily evident that a number of tumors originating in the soft structures present a fairly characteristic and constant appearance. Among these are the lipomas, the hemangiomas, and the glomus tumors. The liposarcomas studied were all quite dissimilar to synovioma. First, they were not near a joint and in addition each had plentiful calcification with a very heterogeneous internal pattern showing areas of radiolucence.

Five cases of fibrosarcoma were also studied. None were located in the immediate joint area, a point sufficient to exclude them at once from consideration. One tumor showed an area of bone erosion, 2 revealed areas of periosteal activity and 1 contained a few small calcific flecks. These tumors were homogeneous in structure and oval to spherical in configuration. Except for location and a somewhat greater incidence of calcification, bone and periosteal involvement, a close resemblance to synovioma was found.

The myosarcomas were also located away from the joint area and therefore were readily distinguished from synovioma. However, except for the location these tumors simulated synovioma because they were oval, their borders were fairly distinct, there was no calcification or bone change. Only 1 of the tumors presented a somewhat heterogeneous internal structure.

Other less frequent new growths such as "myxosarcoma" of tendon sheath origin and plexiform neuroma may also resemble synovioma, but again the location away from the joint is the most helpful point. Two cases of tendon fibroma showed an abundance of calcification as a distinguishing point.

Four cases of giant cell tumor of tendon origin were also studied roentgenologically. In general, it may be said that these tumors resemble synovioma rather closely. One reason for this is the intimate relationship of giant cell tumors of tendon origin to the joint. One of these tumors revealed a relatively large area of bone destruction. Another had calcific flecks and 2 presented extreme degrees of lobulation. All were located in the digits except 1 at the ankle joint, so that location at the digits may be a significant point in differential diagnosis.

Our experience with synovial cysts has been rather limited, but we believe that the characteristic location, the spherical configuration with perfectly smooth sharp border, and the presence of a general change within the joint should be determining factors. Similarly the clinical findings, particularly palpation of the swelling, should be important. When doubt exists, resort to pneumoarthrography might be valuable as the final step in roentgen study.

Villonodular synovitis is another condition that we have encountered infrequently. In the few cases we have seen, the presence of a diffuse change within the joint is considered the important differential point roentgenologically. It would be our opinion that the multiple, relatively small tumefactions within the joint and the occurrence of general synovial joint changes contrast sharply with the findings in synovioma, which is a single tumor not wholly contained within the joint and unassociated with a general soft tissue joint change. Osteoporosis is not usually seen in villonodular synovitis of the knee. In addition, the clinical findings might serve to indicate the diagnosis of villonodular synovitis.

In summary, it would seem that most tumors arising in the soft tissues could be separated from synovioma roentgenologically, either because of their own peculiar characteristics or because of their tendency to be located outside the joint areas. In those instances where myosarcoma or fibrosarcoma were close to the joint, differentia-

tion would probably be impossible, other things being equal. We would expect little difficulty with synovial cysts or with the uncommon condition of villonodular synovitis. Although giant cell tumor of tendon origin may closely resemble synovioma, it seems to have a tendency to occur at the smaller joints.

SUMMARY AND CONCLUSIONS

1. Thirty-two histopathologically proved synoviomas have been studied roentgenographically.

2. Synovioma appears on the roentgenogram as a solitary, homogeneous, water density mass, closely associated with a joint. Its average size is 7 cm. in diameter, its margins are regular, and it occurs most often at the knee.

3. Differential diagnosis concerns certain new growths of the soft tissues when they occur at or near a joint, as well as synovial cysts and villonodular synovitis.

4. This study indicates that all clinically recognizable synoviomas should be identified on the roentgenogram, and that often it would seem possible for the roentgenologist to suggest the diagnosis of this tumor.

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PYOGENIC OSTEOMYELITIS OF THE SPINE*

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PYOGENIC osteomyelitis of the spine is not too common, but the complexities of the clinical manifestations are such that errors in diagnosis are frequent. It is not unusual for patients to go months before the true nature of their disease is discovered. The close anatomical relationships between the diseased vertebrae and segmental nerves, pleura and peritoneum lead to several recognized syndromes which are best classified as abdominal, thoracic, central nervous system, hip-leg and spinal syndromes.[3]

The present series consists of 33 cases of pyogenic infection of the spine which are arbitararily divided into acute, subacute, and chronic types. Twenty-eight patients were males and 5 were females. The age incidence was as follows—1 case in the 1–10 year group, 4 in the 10–20 year group, 7 each in the 20–30, 30–40 and 40–50 age groups; 6 in the 50–60 year group and 1 in the 60–70 year group. Topographically there were 3 cases involving the cervical spine, 7 the dorsal segments and 23 the lumbar vertebrae.

Symptomatically the patients fell into the previously mentioned categories. Twenty complained of back pain. Three gave as the chief complaint pain in the chest, 5 manifested the so-called hip-leg complex, 4 patients had abdominal pain and 1 evidenced meningeal signs. Ten cases we considered as acute, 4 as subacute and 19 as chronic. This particular classification is somewhat questionable, for a number of the patients when seen had had symptoms for some length of time, and may well have gone through an unrecognized acute phase.

Laboratory studies showed moderate leukocytosis in most of the cases, with the highest counts in the acute group. The causative organisms were cultured from the blood stream in 3 and grown from pus in others. All of our cases showed negative reaction to tuberculin skin test.

A proper roentgen evaluation of spinal axis infection rests upon an understanding of the pathological anatomy and a brief résumé of the latter is warranted.

The individual vertebra is so constructed that it is a relatively fertile field for infection. There is a large sinusoidal venous system[5] in the cancellous portion of bone that lends itself well to stasis and thus to bacterial proliferation. Organisms which lodge and grow will cause destruction of bone trabeculae so that the inner vertebral structure may become weakened and thus collapse. In some instances the infection starts close to and actually involves the bony plates so that they give, again resulting in some degree of collapse. Also, with this type of destruction, herniation of the nucleus pulposus may take place. The extent of trabecular and cortical involvement may be minimal, or because of bacterial virulence may involve the entire body. The bones making up the arch are not immune to infection and the same type of destruction described above may well involve the arch. Also, the spinous and transverse processes are likewise susceptible to pyogenic involvement.

An important phase of the reaction to pyogenic organisms is the rather early typical osteoblastic response. Thus, concomitant with necrosis and dissolution of bone is a significant production of new bone, a reaction which is far different than that seen in early tuberculous infection of the vertebra.

Of great importance is the proteolytic effect of enzymes which serve to destroy non-osseous matrix and also to destroy the

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intervertebral disc. Much has been said concerning the disc blood supply, but except in the very young, no ample vascular network is demonstrable.[1] The evidence points to dissolution of the disc by the direct extension of infection. This may occur either by the disc herniating into the diseased vertebra and coming into contact with the infection, or by spread of infection to the disc. In either event, the disc is apt to be involved.

Soft tissue extension of pyogenic disease is not as prominent a feature as in tuberculosis, where massive spread under the ligaments takes place producing large paravertebral abscesses, as well as spreading the disease to other segments.[2] In pyogenic infections, localized paravertebral abscesses occur occasionally, but the spread from one segment to another is usually by direct extension across the disc spaces. Erosion by pus collected under the anterior ligaments is not present as in the granulomatous infections. However, spread into the psoas sheaths is rather common because of the direct avenue of access to the psoas attachments.

The changes described above logically lead to certain roentgen features. The one disease with which pyogenic infection of the spine is most apt to be confused is tuberculosis. Certainly, in some early cases a definite differentiation is impossible, particularly in the localized type. Here, in both diseases, the earliest abnormality may be

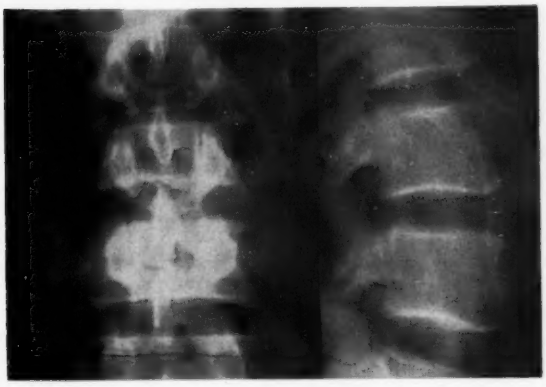

Fig. 1. There is a small radiolucent area in the anterior, superior segment of the third lumbar vertebra.

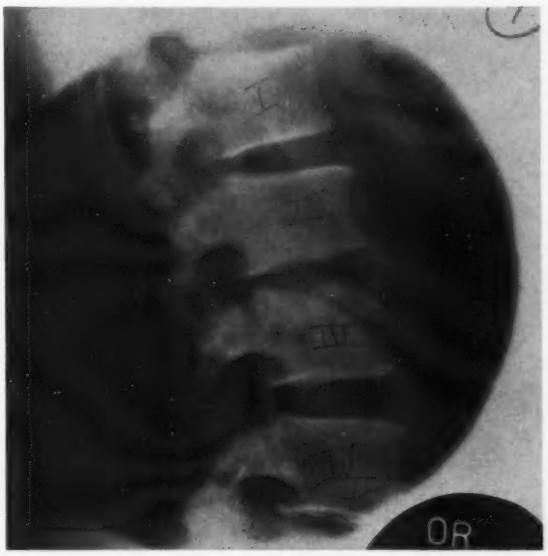

Fig. 2. This demonstrates bony proliferation along the anterior ligament between L2 and L3. Roentgenogram taken nine weeks after onset of disease.

a narrowing of the disc space. The earliest bone change, however, is rarefaction, either at the center of the body or at the superior or inferior lips anteriorly (Fig. 1). Close study of the trabecular pattern will frequently lead to appreciation of rarefaction. Subsequent spread of the infection enlarges the zone of rarefaction. Minute details must be assessed carefully, for it has been shown experimentally and clinically that small foci of trabecular destruction are clearly visible on roentgenograms of good quality, more visible in fact, than similar areas of destruction in the compact bone at the periphery. The changes thus far described may represent either pyogenic or tuberculous disease. Certain features, however, serve to distinguish between the two. One, in pyogenic disease the degree of demineralization is more marked and, two, the progress of bone destruction, when followed by serial studies, is much more rapid.

Even more important in separating pyogenic disease from tuberculosis is the relatively early appearance of bone reaction and proliferation in the former.[4] Within a period of four to six weeks it is possible to identify sclerosis and subligamentous new bone formation (Fig. 2), whereas such

FIG. 3. An example of the dense bridging between vertebrae. Also, note sclerosis in the bodies.

changes seldom appear earlier than six to nine months in acid-fast infections. Thus, a serial sequence of films often leads to a definite differentiation. Bone sclerosis may occur in tuberculosis of the spine, but it is certainly not a prominent feature and when present is very likely due to secondary infection.

Another important aspect of the roentgen pattern in osteomyelitis is the dense, thick bridging between adjacent vertebrae (Fig. 3). This often forms within a few months. These coarse osteophytic formations are practically never seen in tuberculosis, but are common in pyogenic involvement.

Primary involvement of either the spinous process, transverse process or any part of the arch without evidence of disease in the vertebral body points to pyogenic rather than tuberculous involvement. Even when the body shows destruction, arch changes are suggestive of non-acid-fast disease. Interestingly enough, pyogenic infections are usually accompanied by lesser degrees of deformity and disc collapse than tuberculosis. This we would attribute to the chronicity of tuberculosis, thus permitting marked, relentless caseation with intense vertebral disruption and collapse. Recently, however, we have had the opportunity to follow the progress of tuberculous spondylitis in patients treated with streptomycin and the roentgen pattern was somewhat different than usual. The infection was arrested rather early in its course and very little collapse took place. Perhaps the entire morphology of tuberculous disease of the spine may be altered with the advent of specific modes of therapy.

Disc narrowing is probably the result of direct destruction by bacterial products as well as protrusion into the weakened bodies. Another factor of significance is, we believe, related to the patient's activity. Those who take to bed early in the course of their disease usually show less marked disc space narrowing and vertebral collapse, chiefly because the incessant stress and trauma occasioned during routine walking and activity have been significantly lessened.

As mentioned previously, soft tissue changes may be absent or minimal. When present they take different forms depending on which spinal segments are involved. In the cervical regions, there may be a loss of the usual intermuscular stripes or even some anterior displacement of the pharyngeal and tracheal air shadow. In the thorac-

ic spine, globular paravertebral swelling may be present, but usually this is not so marked as in tuberculosis. In the lumbar segments paravertebral abscesses do not occur as such, for if pus escapes it usually finds its way into the psoas sheath either unilaterally or bilaterally. Thus, the psoas stripes on roentgen examination will bulge or become indistinct.

DISCUSSION

It would seem that clinical evaluation should prove no puzzle, especially in those patients with back pain as a presenting complaint. However, back symptoms are all too often considered as due to arthritis, disc rupture, pelvic disease or trauma. Also, physicians all too frequently ascribe back pain as a common symptom in a host of systemic diseases. Thus, the patient is often referred to the roentgen department with suspicion of one of the mentioned disorders. The roentgenologist, not alerted, is very apt to overlook very important minor aberrations. In order to obviate such pitfalls, the films must be of excellent quality, must be scrutinized with extreme care—and, of utmost importance, must consist of more than the routine anteroposterior and lateral projections. Oblique studies are obligatory and spot roentgenograms are invaluable. It is necessary to examine films under direct spotlight whenever the transverse or spinous processes cast an indeterminate shadow, otherwise small areas of disorganized bone will be overlooked. Laminagraphic studies should prove helpful in assessing minor changes and should be used more frequently.

Attention to details in the history is imperative. Too often physicians tend to disregard certain odd features. This was well exemplified in one of the patients who complained of back pain following sympathetic nerve block for a vascular disturbance. He was diagnosed as a case of hypertrophic arthritis, but eventually the roentgenograms showed destruction of one transverse process and staphylococci were cultured from aspirated material. In another instance, persistent lumbar pain was related to the patient's severe hyperthyroid state. A streptococcus osteomyelitis involving two vertebrae finally manifested itself.

The more baffling problem involves the group of patients who complain of chest pain, abdominal symptoms, hip-leg syndrome or meningeal symptoms. Thoracic spine osteomyelitis may produce radicular-like pain or pleural pain which leads to roentgen study of the chest. A negative pulmonary and cardiac study leads to a false evaluation that no important disease is present. Any persistent chest pain that remains unexplained may be secondary to spine involvement, hence it is wise in such cases to suggest vertebral roentgen studies.

Abdominal pain associated with muscle spasm may prove distressingly misleading. Physical examination of the abdomen is usually considered indicative of abdominal disease, but deep palpation is often well tolerated and rebound tenderness is usually absent. Rectal examination elicits no positive findings. Nausea and vomiting are not conspicious symptoms. Superficial evaluation, however, may lead to serious errors. One of our patients had an appendectomy without, of course, relief of symptoms. He was restudied and lumbar osteomyelitis was demonstrated.

The hip-leg syndrome is most often confused with primary hip joint disease. The patient with osteomyelitis of the spine at times has hip and leg pain associated with muscle spasm and flexion contracture. He voluntarily limits motion; passive manipulation induces intense pain. Deep hip palpation and direct trochanteric pressure, however, elicit no pain. Roentgen studies of the hip will prove normal. Whenever such a clinical picture is manifest and roentgen hip survey is negative, it is imperative that the lumbar spine be studied very carefully both clinically and roentgenographically.

We have had only one case of pyogenic osteomyelitis associated with meningitis. The patient, following a spinal operation, developed some time later a meningitis,

and spine studies showed rather marked destruction of the bones in the neural arch. Subsequent operation showed pyogenic disease of the neural arch.

Certain patients show features that tend to simplify the problem. The acute back associated with fever, malaise, leukocytosis, rapid pulse, stiffness, muscle splinting, etc., alerts the clinician to the true nature of the problem. However, when these features are absent, we are apt to be misled. Moreover, in our series less than half the group had the findings just mentioned and thus were often misdiagnosed. In certain cases, months elapsed before a correct evaluation materialized and one patient was seen over a two year period prior to discovering his vertebral osteomyelitis.

Now that we are in the dramatic era of chemotherapy and antibiotics it might appear that this problem is lessened. While it is true that in some cases so-called blind therapy may alleviate the symptom and heal an undiagnosed diseased process, by the very nature of pyogenic osteomyelitis consistently good results with such a regimen cannot be anticipated. All too often, unless drainage is established, cure is impossible and irreversible changes of significance may ensue. Hence, it behooves both clinician and roentgenologist to be ever alert.

A large percentage of our cases were incorrectly evaluated both clinically and roentgenographically. Yet, rather than attempt a justification, we would vigorously stress the necessity for abandoning the so-called routine interpretation of spine films. Each and every case must be studied with extreme care. If the spine is considered as worthy of roentgenographing, then it deserves to be projected in more than the usual two positions. Multiple views should be made and each vertebral segment must be studied with more than casual interest. Only then can we aid our clinical colleagues to the fullest; only then do we merit our orientation as a consultant. A correct roentgen interpretation may prove to be the first link in the proper management of the often perplexing problem of pyogenic osteomyelitis.

CONCLUSIONS

1. Thirty-three cases of pyogenic osteomyelitis are presented.
2. Five clinical syndromes are discussed.
3. The pathological anatomy of pyogenic osteomyelitis is correlated with the roentgen changes.
4. Pyogenic osteomyelitis is characterized roentgenographically by rarefaction, early bone sclerosis, relatively early bone spurring, by intervertebral disc destruction and occasional paravertebral abscess formation.
5. Serial roentgen studies will usually differentiate between pyogenic and tuberculous infection of the spine.

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Vol. 67, No. 1

DEGENERATIVE OSTEOARTHRITIS OF THE HIP JOINT

PATHOGENESIS OF THE ENLARGED FEMORAL HEAD (COXA MAGNA) AND DEFECTIVE ACETABULUM

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THIS is an analysis of the pathologic and roentgenographic background of that form of degenerative osteoarthritis (more accurately, osteoarthrosis) of the hip joint, in which the dominant changes are observed to occur in the superior or proximal portion of the joint. Particular attention is focused on those cases which arise without any known basis—the so-called primary type, yet in which the roentgenographic and pathologic features are indistinguishable in the more advanced stages from the secondary osteoarthritis of the hip joint following such well defined lesions as Perthes' disease or displacement of the capital femoral epiphysis.

In this primary type, the flattened, mushroom-like or cauliflower-type deformity of the femoral head develops from a combination of loss of articular cartilage over the superior, weight-bearing portion of the femoral head, deposition of bone at the head-neck junction, particularly medially, laterally and posteriorly, and widening of the femoral neck by periosteal bone production. Indeed, the original outline of the femoral head may often be delineated. Furthermore, the acetabular roof becomes sloping and there occurs a variable amount of lateral displacement of the enlarged head. These latter features make the terminal picture in these cases indistinguishable from the secondary type of degenerative arthritis which becomes superimposed on a congenital dysplastic acetabulum with or without subluxation of the femoral head.

Since so many dissimilar or unrelated conditions may terminate with identical roentgenographic and pathologic pictures, any accurate study of degenerative arthritis of the hip joint, particularly in regard to its later stages, should include an analysis of serial roentgenograms which depict the evolution of the joint lesion in each instance. Furthermore, recognition of this fact has a direct bearing on the evaluation of the long range treatment of any primary condition which may affect the hip joint, particularly in relation to the appearance of secondary degenerative changes. Certainly such quotations from an excellent article on this subject,[4] as "Here again the radiographic appearance is so characteristic as to justify the diagnosis of the primary condition even when a history cannot be obtained" in reference to the late roentgenographic changes in Perthes' disease, or "In all of the above cases the radiographic appearance of osteoarthritis was so characteristic that one is justified in assuming such an aetiology when this appearance is seen," in reference to slipped capital femoral epiphysis, are inaccurate and misleading.

Correlation of Etiology with the Pathologic and Roentgenographic Features in So-called "Primary" and "Secondary" Types of Degenerative Arthritis of the Hip Joint. Any process which alters the anatomy of the hip joint, more particularly that of the femoral head and acetabulum and the contiguity of their articular surfaces, will accelerate the development of degenerative changes of the *secondary* type (Fig. 1 and 3*C*).

Deformity which involves the head of the femur initially, will be observed, among other conditions, following Perthes' disease, aseptic necrosis due to causes other than Perthes' disease, coxa vara, particularly the congenital or developmental form, slipped capital femoral epiphysis, localized

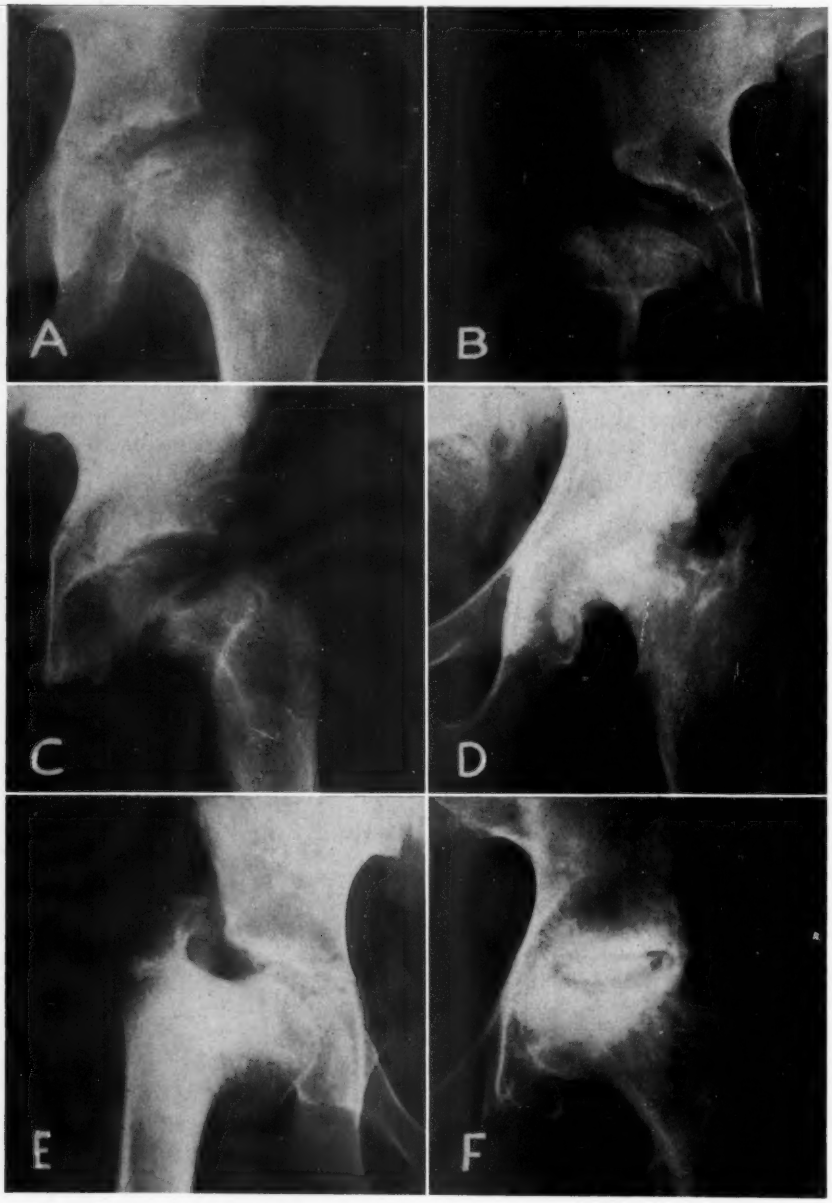

FIG. 1. Lesions which affect the head of the femur primarily and which lead to its early deformity and to joint incongruity, serving as the basis for the development of a secondary type of degenerative osteoarthritis of the hip joint.

(*A*) Perthes' disease, (*B*) Perthes' disease healing with coxa vara deformity, (*C*) displacement of the capital femoral epiphysis, (*D*) advanced aseptic necrosis secondary to severe displacement of the capital femoral epiphysis, (*E*) congenital (developmental) coxa vara, (*F*) localized aseptic necrosis of the femoral head.

Note particularly the secondary adaptive changes in the acetabular roof in each instance, for the earlier films illustrated normally developed acetabula.

lesions such as osteochondritis dissecans, synovial osteochondromatosis and articular fractures.

A sloping acetabular roof may develop as the result of remodeling and adaptation to fit a primarily deformed head, and this will be more evident in the earlier decades of life (Fig. 1). On the other hand, anatom-

ical variations which involve the acetabulum primarily, especially when there is an associated displacement of the femoral head, will be followed in time by secondary degenerative joint changes (Fig. 3, *C* and *D*). The effect of the femoral head and the acetabulum upon each other is demonstrated very strikingly on comparing the advanced degenerative changes in a congenitally subluxated hip with the lesser alterations in the opposite completely dislocated hip in the same subject.

The roentgenographic findings and pathologic changes in this secondary type of degenerative arthritis of the hip joint are dominant in the superior or proximal portion of the joint. The femoral head becomes enlarged and flattened, a deformity which may only be apparent and consequent upon marginal proliferation, or real, as the result of actual collapse of the articular surface.

A different roentgenographic picture evolves in another group of the secondary type of degenerative arthritis, excluded from this study, where the degenerative changes become engrafted upon a joint primarily affected by rheumatoid arthritis or by chronic joint infection (*e.g.*, gonococcal) or where the bony structures are softened incidental to local or systemic skeletal disease. Here the narrowed joint space may become further obliterated as the femoral head protrudes deeply within the acetabulum or even bulges intrapelvically.

There remains a group of cases, reported as comprising from 40 to 60 per cent of all instances of degenerative arthritis of the hip joint (Plewes,[4] Wiberg,[5] Horwitz,[3] among others) in which the pathogenesis is uncertain or where there has been no clearly defined pre-existing lesion—the so-called *primary* type. The degenerative processes in many of these cases have been attributed to attritional changes resulting from repeated trauma or following the wear and tear of function, the effects of body weight and as an expression of senescence.

The recent studies of Wiberg[5] clarify the background of some of these cases. He has demonstrated a primarily defective or hypoplastic acetabular roof in a number of instances of advanced osteoarthritis of the hip joint.* Indeed, that author, as do others who have emphasized the importance of this factor, would attribute the etiology of one-fourth of all cases of degenerative arthritis of the hip joint on the basis of a dysplastic acetabulum, with or without subluxation of the femoral head.† Since these cases are more properly classified as secondary in type, it appears that the so-called primary type occurs far less commonly than has been previously suspected. The writer accepts the primary type of degenerative arthritis as a lesion sui generis arising without evidence of any anatomical disturbance of the joint or of any pre-existing lesion or disease process (Fig. 2 and 4*A*).

The "Proximal" Type of Degenerative Arthritis of the Hip Joint. Hermodsson[2] has designated as the "proximal" type of degenerative arthritis of the hip joint those cases in which the pathologic and roentgenographic changes first appear and remain most advanced in the superior portion of the joint. Those cases wherein the degenerative changes—joint narrowing, osteosclerosis and cystification—are most prominent in the medial portion of the

* For the early roentgenographic recognition of hypoplasia or deficiency of the acetabular roof, Wiberg suggests use of the *CE* angle, in which *C* marks the center of the femoral head and *E* the point where the acetabular roof terminates laterally and meets the posterior acetabular wall. He defines this angle as one formed by the line *CE* and a line drawn through *C* in the longitudinal axis of the body. An angle below 20 degrees is indicative of defective development of the acetabular roof, values over 25 degrees are normal and those between 20 and 25 degrees are "borderline." However, the value of this measurement appears, to the writer, to be restricted to the earlier phases of degenerative arthritis of the hip joint, for as this process evolves, points *C* and *E* become difficult to locate accurately, and point *C* migrates as the femoral head becomes luxated.

† In this country, Hart,[1] who has given much attention to acetabular dysplasia and its relation to congenital subluxation and dislocation of the hip, recognizes a third and related deformity—*i.e.*, primary dysplastic acetabulum without evidence of displacement of the femoral head—as a clinical entity, with a proclivity for complication by secondary joint changes late in life on the basis of anatomical incongruity and acetabular instability. This author, who has borrowed freely from Faber, has ascribed this concept to Preiser who in 1907 presented the concept of osteoarthritis of the hip joint developing secondary to poor adaptation of the femoral head and the joint cavity.

FIG. 2. Early degenerative osteoarthritis of the hip joint (primary type) in an adult female, aged sixty-seven. There were no symptoms or abnormal physical findings referable to this hip or the ipsilateral knee. The degenerative changes are minimal, as manifested by slight flattening and broadening of the femoral head, early cystification of the subchondral bone of the head and sclerosis of the acetabular roof with some narrowing of the joint space—a very early expression of the "proximal" type of osteoarthritis of the hip joint. By measurements, there is no actual lateral displacement of the femoral head, and the configuration of the acetabular roof is normal (*CE* angle, 24 degrees; floor distance, 8 mm.). The "tear drop" is clearly visualized and Shenton's line is unbroken.

Significant anatomical landmarks are:

a—Step-shaped transition between the roof and medial wall of the acetabulum. This depression is caused by the deepening of the fossa acetabuli.

abd—The outer side of the "tear drop" ("U-figure") or medial acetabular wall; *cd*—The inner side of the "tear drop" or shadow of the inner pelvic wall; *d*—The opening where the fossa acetabuli curves inwards to meet the wall of the true pelvis. The "tear drop" is best visualized on an anteroposterior view made with the tube centered over the midpelvis and not over the hip joint itself.

e—Anterior border of the posterior horn of the lunate surface of the acetabulum (Wiberg).

C—Center of the femoral head.

E—Lateral edge of the acetabular roof and its junction with the posterior acetabular wall.

Shenton's line—Continuous line along the inner curve of the neck and upper border of the obturator foramen.

joint, have been classified as the "medial" type. These terms, therefore, refer to the location of the dominant anatomical and roentgenographic changes and are not to be confused with the terms "primary" and "secondary," which apply to present concepts of the etiologic background and pathogenesis of degenerative arthritis.

The picture of a proximal type of degenerative arthritis may evolve secondary to a variety of unrelated and often dissimilar lesions which primarily involve the femoral head and/or acetabulum. Specifically, the head may become flattened and mushroomed due to its actual collapse incidental to an underlying aseptic necrosis, or it may become hypertrophied as a result of displacement of the capital femoral epiphysis. A broadened and flattened femoral head may develop on the basis of such localized lesions as osteochondritis dissecans or osteochondral fracture. On the other hand, a primarily defective acetabular roof may serve as the basis for severe secondary degenerative changes in the femoral head and hip joint.

On the other hand, an identical roentgenographic picture may evolve without any specific pre-existing lesion as a background for the degenerative arthritis. The work of Wiberg indicates that the pathogenesis in some of these cases is related to a primary hypoplasia of the acetabulum. Those instances with normally developed acetabula represent the "primary" type. In these cases, the femoral head becomes enlarged and apparently flattened as the result of the combination of loss of articular cartilage over the proximal or weight-bearing portion of the head and peripheral bone deposition at the head-neck junction. In such instances the outline of the original

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CE Angle—The angle between the line *CE* and a line through *C* in the longitudinal axis of the body, which normally measures above 25 degrees (Wiberg).

Floor Distance—The distance between the medial outline of the femoral head and the outer border of the "tear drop," which normally measures 7 to 10 mm. (Hermodsson).

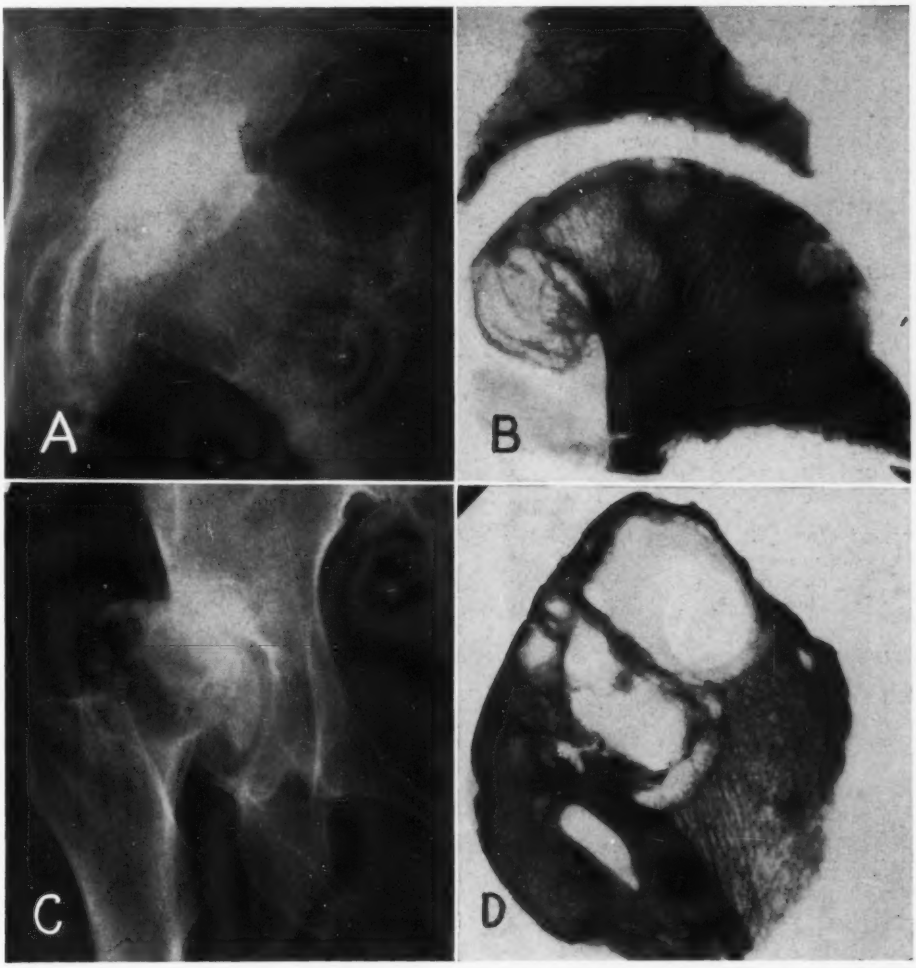

Fig. 3. (*A*) Degenerative osteoarthritis of the hip joint of the "proximal" type in a female, aged sixty. The anatomical specimen removed at autopsy (*B*) revealed no pre-existing lesion of the femoral head or acetabulum. The appearance of a broad, flat, mushroom-like head was found to result from a combination of loss of articular cartilage superiorly, where the bone was densified and cystified, and marginal bone proliferation, medially, posteriorly and laterally where it extended over the femoral neck. The femoral head was displaced laterally, seemingly by the large medial deposit on the femoral head, there being little or no deposition on the acetabular side, despite the roentegnographic suggestion of a "double acetabular floor" in (*A*).

(*C*) Degenerative osteoarthritis of the left hip joint of a female, aged forty, with many of the roentgenographic features illustrated in (*A*), but in this instance on a known basis—*i.e.*, secondary to a congenitally subluxated femoral head and dysplasia of the acetabulum. The basis for the hypertrophy in this instance is illustrated in (*D*), a roentgenogram of a section of the femoral head removed surgically from the opposite hip where the subluxation was more advanced. The enlargement was due largely to an enormous proliferation of bone on the *medial* and posterior aspects of the femoral head and the *inferior* surface of the femoral neck, and it was this bony deposit which occupied most of the residual acetabulum. The inferior portion of the original head alone contacts the acetabular roof.

femoral head may not infrequently still be delineated. The femoral head becomes luxated superolaterally and the acetabulum assumes a sloping appearance.

In the "proximal" type of degenerative arthritis, the interval between the head and medial acetabular wall becomes filled with a bony deposit which is usually more

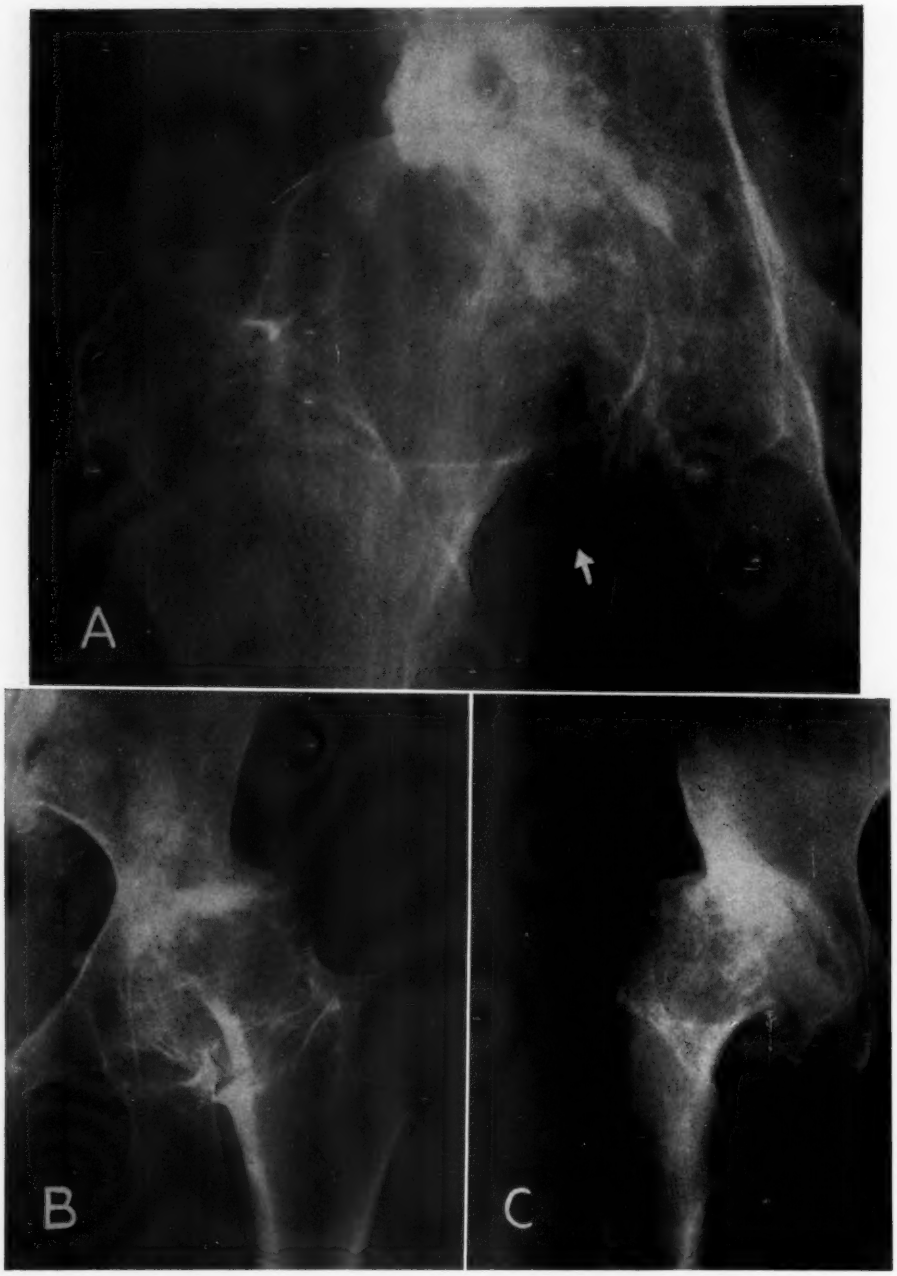

FIG. 4. Degenerative osteoarthritis of the hip joint of the "proximal" type, moderately advanced in (*A*) and well advanced in (*B*) and (*C*). In each instance, the femoral head is displaced laterally and away from the medial acetabular wall, the interval being filled with bone which is deposited largely on the medial aspect of the head and, to a less extent, on the medial wall. The hypertrophy of the femoral head is due to this medial capital deposit of bone and to that on the lateral aspect of the head and neck. The bone is sclerotic at the proximal or weight-bearing portion of the hip joint where the joint space is considerably narrowed. The "tear drop" is not clearly defined and Shenton's line is broken in each illustration.

The appearance in (*B*) might represent the terminal roentgenographic features following slipped capital femoral epiphysis or consequent upon primary dysplasia of the acetabular roof with subluxation of the femoral head; that in (*C*) could represent the terminal picture following Perthes' disease of the femoral head, aseptic necrosis of origin other than Perthes' disease, or a primarily dysplastic acetabulum and subluxated femoral head—*i.e.*, the secondary type of degenerative osteoarthritis. On the other hand, these

extensive on the medial lip of the femoral head (the "capital drop") than it is on the acetabular side (the "double acetabular floor") (Fig. 3 and 4). Displacement of the femoral head may become furthered by this bony deposit, as well as by the adduction deformity of the thigh, which is so common in these cases. Wiberg has found the "double acetabular floor" to be a formation of new bone at the inner edge of the lunate surface, extending in towards the acetabular fossa. It is my impression that what is often interpreted, roentgenographically, as a "double floor" is more frequently bony deposition on the medial lip of the femoral head. This capital deposit extends posteriorly and this can be visualized in Lauenstein's position.

SUMMARY

Roentgenographically, degenerative arthritis of the hip joint is generally interpreted on the basis of narrowing of the joint space consequent upon thinning and loss of articular cartilage, and bony proliferation or exostosis formation. Anatomically, this bony proliferation may ring the articular surfaces peripherally to a variable degree or it may appear as elevations or bumps on the articular surface itself. In the more advanced stage of the "proximal" type, the hypertrophied femoral head may protrude laterally from the confines of the acetabulum and this appearance will be exaggerated by actual lateral displacement of the head and by a sloping acetabulum. The interval between the femoral head and medial acetabular wall becomes filled by a large exostosis on the medial lip of the femoral head and, to a lesser extent, by a deposit of bone on the acetabular side. It is this deposit in concentric rings and the sloping acetabulum which give rise to the impression of a "wandering acetabulum."

Such a picture will evolve on the basis of a variety of unrelated and often dissimilar lesions which primarily affect the femoral head and/or acetabulum. The degenerative changes will become modified by the nature of, and their evolution will be hastened and exaggerated by the severity of the underlying lesion. On the other hand, identical roentgenographic and pathologic pictures may develop with maximal joint changes also in the superior or proximal portion of the hip joint, where the femoral head presents no intrinsic disease process and is flattened only apparently, from a combination of articular cartilage erosion and peripheral bone hypertrophy. The work of Wiberg indicates that the pathogenesis in some of these cases is related to a primary hypoplasia of the acetabular roof. Those instances with normally developed acetabula represent the primary type of degenerative arthritis of the hip joint.

Because many conditions which are varied and often unrelated may eventuate in a degenerative osteoarthritis of the hip joint with roentgenographic and pathologic features which are identical in their terminal pictures, any survey of this lesion must include an analysis of the earlier roentgenograms in each instance in order to determine the background and pathogenesis accurately. This has a very direct bearing on the evaluation of methods for treating these pre-existing lesions of the hip joint, especially in relation to the prevention of secondary degenerative joint changes.

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same features are observed in (*A*) where the degenerative lesion appears to be of the primary type, there being no demonstrable pre-existing lesion in the femoral head or acetabulum. The pathogenesis in (*B*) and (*C*) is obscure without earlier roentgenograms to demonstrate the evolution of the degenerative arthritis.

There is no measureable deficiency of the acetabular roof in (*A*) and the *CE* angle of 18 degrees is due to the lateral displacement of the femoral head, the floor distance having increased from 8 to 15 mm. This indicates the limited value of the *CE* angle as an index of acetabular deficiency per se.

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A CASE OF OSTEOGENESIS IMPERFECTA DIAGNOSED IN UTERO*

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MANY articles about osteogenesis imperfecta appear in the literature and many of the standard textbooks describe the disease fully. This is believed to be the second reported case in which the diagnosis was made in utero, the first case being reported by Danelius[4] in Germany. Brailsford[2] in his textbook, "Radiology of the Bones and Joints," gives a good account of the disease and shows an anteroposterior roentgenogram of a pregnant woman on which can be identified a large intra-abdominal mass within which are two "ill-defined opacities." The film was first diagnosed as an ovarian cyst and the opacities were interpreted as calcified glands. More careful examination of the roentgenogram revealed that the opacities showed the characteristics of petromastoids, and with this identification it was possible to recognize a very faint outline of a fetal skull. Roentgenograms of the stillborn fetus showed typical osteogenesis imperfecta.

In the case to be reported, no fetal parts could be identified in the anteroposterior view, although several films employing various techniques were made here and by another roentgenologist. However, a lateral view of the abdomen demonstrated a poorly calcified fetal skeleton showing the typical characteristics of osteogenesis imperfecta.

CASE REPORT

A pregnant woman, aged twenty-nine, was admitted to St. Luke's Hospital, St. Louis, Missouri, on July 22, 1949. She had been pregnant twice before and had had 2 normal healthy children. Her expected date of confinement was October 7, 1949. The pregnancy had been uneventful until three weeks before admission, at which time she noticed a generalized abdominal pain and cramping accompanied by a marked increase in size of the abdomen. A routine examination by her doctor on June 27, a few days before onset of her abdominal pain and cramping, revealed nothing abnormal. However, by July 16 her abdomen had increased markedly in size and the pain was so severe that she again consulted her doctor who advised her to enter the hospital.

Physical examination was negative except for a marked smooth symmetrical enlargement of the abdomen. The McDonald measurement was 39 cm. as compared to a normal term measurement of 35 cm. Fetal small parts could be felt but the head could not be identified. No fetal heart tones could be heard. Vaginal examination revealed a soft cervix whose external os admitted the tips of two fingers; the presenting part was not engaged and the membranes were tense over the internal os.

Clinical diagnoses: (1) hydramnion; (2) fetal death; (3) fetal abnormality (?).

The patient was sent for roentgen studies on July 23, 1949. Anteroposterior and left lateral views of the abdomen were made.

Membranes were ruptured artificially at 8:30 A.M. on July 25 and a stillborn fetus showing characteristic features of osteogenesis imperfecta was born at 1:00 A.M. on July 26, 1949.

When the anteroposterior view was studied, a large, smooth, rounded, soft tissue mass could be seen. This extended up from the pelvis and bulged far laterally into each flank. Films taken a few days previously by another roentgenologist revealed the same findings. On repeated examination with varying techniques, no fetal skeletal parts could be identified on the anteroposterior views. On the lateral view, a small, partially calcified, fetal skeleton could be seen lying within a greatly enlarged uterus. The skull and facial bones were invisible except for the petrous pyramids. The spine was fairly well shown and nothing abnormal could be noted. Both scapulae were distinguishable but neither upper extremity could be seen. All the ribs, especially their spinal ends, were faintly shown. Each lower extremity was broad, short, and stumpy, and bore no resemblance to the

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FIG. 1. Lateral view of the pregnant mother two days before delivery. Fetal skeleton is poorly calcified; the head and facial bones cannot be identified. Both lower extremities are broad, short, and deformed. Arrow indicates lower extremities.

normal. One of the femurs was sharply angulated at one point suggesting that it was fractured.

Roentgen diagnoses: (1) hydramnion; (2) osteogenesis imperfecta.

Differential Diagnosis.

1. *Fetal Death.* It is known that after fetal death, demineralization occurs after a time. However, fetal heart tones had been heard three weeks previously and fetal death alone would not explain the deformed lower extremities.

2. *Anencephalus.* This diagnosis fails to take into account the extreme demineralization of the fetus and the deformed lower extremities.

3. *Fetus papyraceous* is ruled out by the fact that no normal twin could be demonstrated.

4. *Chondrodystrophy Fetalis.* Short, stumpy long bones occur but this disease does not explain the marked demineralization or the questionable fracture of one of the femurs. The only diagnosis remaining that completely satisfied all the findings noted is osteogenesis imperfecta.

The entire fetal skeleton can be made invisible by motion of either the fetus or mother during the exposure. If the clinical picture is not taken into account, an erroneous diagnosis of ovarian cyst or pelvic tumor will be made. This set of circumstances may be encountered if only a single anteroposterior view of the abdomen is made. When there is undeniable evidence of pregnancy at or near term, the failure of visualizing a fetal skeleton demands reexamination and lateral views cannot be overemphasized because they often give positive fetal skeletal identification when the anteroposterior view does not. The pres-

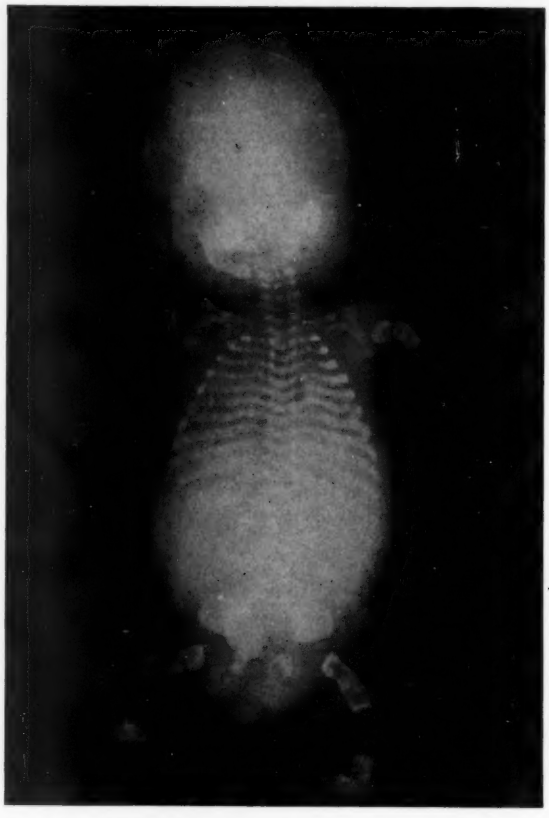

FIG. 2. Roentgenogram of stillborn fetus. Many subperiosteal and pseudofractures. Poor calcification of entire fetal skeleton; changes most marked in skull and facial bones. Note the broad, short, deformed lower extremities.

ence of a hydramnion contributes to the failure of visualizing an extremely decalcified abnormal fetus especially if it is not at term, and this undoubtedly was a contributing factor in this case.

This disorder has been reported under various names such as fragilitas ossium, idiopathic osteopsathyrosis, periosteal aplasia and Lobstein's disease. Among the different classifications suggested, the following is generally accepted.

I. Hereditary type—hereditary hypoplasia of the mesenchyme with brittle bones and blue sclera.
II. Non-hereditary congenital type—
  A. Osteogenesis imperfecta congenita.
  B. Osteogenesis imperfecta tarda.

Some authors have considered hereditary hypoplasia of the mesenchyme a separate disease entity; however, the trend at present is to consider all cases of this disorder as variations of the same disease (Brailsford,[2] Kaufmann,[5] Sumita[7]). It is difficult, if not impossible, to distinguish between the hereditary and non-hereditary types if the history is not known.

In 40 cases reported by Bickel, Ghormley and Camp,[1] 27 per cent were found to be hereditary while the remaining cases were sporadic with no family history obtainable. Most cases of the hereditary type have blue sclera but Camp reports one well defined case that did not have blue sclera. Seventy-two per cent of Camp's non-hereditary type had blue sclera.

No family history of brittle bones was elicited in the case under discussion, and there was no bluish discoloration of the sclera. The film of the stillborn fetus is a classic example of the congenital type. The skull and facial bones are very faintly calcified and at physical examination the skull was easily compressible everywhere and felt more like a fibrous bag than a bony skull. All the extremities are short and stumpy. Numerous fractures are visible. Most of these are of the subperiosteal type with little displacement but marked angulation at the fracture site. Numerous so-called Looser zones are also seen. These are structureless regions of absorption which are found in the long bones and some authors think that these are incomplete fractures.

SUMMARY

1. A case of osteogenesis imperfecta congenita diagnosed in utero is presented.

2. The diagnosis is not difficult if anteroposterior and lateral views of the abdomen are made at or near term.

3. The cardinal diagnostic features are: A. Poor calcification of the fetal skeleton especially of the skull and facial bones. Fetal skeleton may be entirely invisible on the anteroposterior view. B. Short, stumpy, deformed extremities; this is usually most marked in the lower extremities. C. The visualization of multiple fractures.

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A NEW ROENTGEN SIGN OF FETAL DEATH

By STEPHEN NATHANIEL TAGER, M.D., F.A.C.R.*
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DIAGNOSIS of fetal death, by either the obstetrician or the roentgenologist, offers certain hazards. The obstetrician may fail to establish his suspicion for several reasons: (1) an obese patient; (2) presence of hydramnios, making transmission of fetal tones indistinct; (3) poor quality of fetal tones.

Likewise, the roentgenological criteria are not uniformly reliable. The general consensus offers the following signs:

1. Spalding's sign.
2. Flattening of vault of skull.
3. High degree of asymmetry of skull.
4. Marked curvature of fetal spine or angulation of spine.
5. Indistinct bone markings.
6. Failure to change position following repeated exposures at different times. It has been considered possible for a dead fetus to change its position and even turn to an extent of 180°.
7. Collapse of thoracic cage.
8. Skin is separated from vault of skull and a type of halo consequently develops.[3] Scalp tends to separate from skull bones and an unusually wide space between the skull and scalp develops. A bright streak results.
9. Gas in fetal circulatory systems: heart, abdominal vessels, and umbilical cord.[2]

Many authorities believe Spalding's sign,[8] namely, an overlapping of sutures in the absence of labor, to be the most accurate of those listed. The disintegration of the fetus comes later. However, this is not readily accepted universally, as a review of the literature reveals. DeLee[2] states that he has noted overlapping in a living fetus and so has Thoms.[9] A case[5] is actually reported where a live infant was delivered after a roentgenological diagnosis of intrauterine death. Whether skull collapse to the point of overlapping of the skull bones takes place in all instances within a relatively short time after brain collapse is open to question. Thoms also presents a case of fetal death in which roentgen evidence of brain collapse was present and no overlapping was demonstrable at any time. One could conclude that Spalding's sign is unreliable and certainly open to justifiable criticism. Fahmy[4] supports this contention. Finally, Billing[1] has demonstrated that small vertical changes, as much as 0.5 cm., may result in 4.0 cm. overlapping in the roentgenogram. This was based on experiments using glass phantoms (hemispheres). He believes that the reliability of Spalding's sign, *i.e.*, more than 2 cm. *overlapping*, is to be *seriously questioned*. In other words, by projection, Spalding's sign can be simulated.

Schmiemann[6] found a pronounced lordosis of the entire vertebral column. The caput of the fetus appeared to be bent posteriorly, over the left shoulder, at least 100°. The cervical portion of the vertebral column revealed a strong rotation simultaneously on its axis. The mandible of the fetus hung down independently. The arms were extended sideways and the left scapula was widely displaced from the thorax. In spite of this grotesque position, Spalding's sign was negative.

Schnitker, Hodges and Whitacre[7] consider the factor of pseudo-overlapping, which depends upon "superimposed" shadows of suture. They believe the true can be recognized from the false by means of stereoscopic views.

The author offers a new sign based on an extremely simple technique, in which the diagnosis of intrauterine death is easily established. In all cases where the question of fetal death is raised on the part of either the obstetrician or the radiologist, *two*

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views are taken. One is the routine supine anteroposterior projection; the other is the anteroposterior projection taken with the patient *erect*. Both films are taken at 150 ma.-sec., Potter-Bucky grid, 30 inch focus-skin distance, and kilovolts employed according to thickness of part. The films are then examined with particular emphasis placed on the spine of the fetal skeleton, which offers the easiest landmark. If, in the supine view, no abnormalities are found, and the erect view reveals a complete collapse of the spine in the pelvic region, this is undoubtedly pathognomonic and constitutes the sign presented.

Three cases are reported illustrating this principle, in brief.

CASE REPORTS

Case 1. Mrs. E. H., aged twenty-one, white (Hosp. No. 50-776), was admitted on February 21, 1950, stating that no fetal movements had been perceived for the past two days. This was her first pregnancy. She was eight months pregnant at this time and was a known juvenile diabetic. On the day of admission, she had a fainting spell accompanied by some vomiting, after taking insulin at 11:00 A.M.

Fig. 1. Case 1. Supine view, anteroposterior projection.

Fig. 2. Case 1. Erect view, anteroposterior projection.

Physical Examination. No heart tones were heard on examination within the fundus of the uterus. The upper margin of the uterus was one finger's breadth above the navel. Blood pressure, 174/108 on admission (pre-eclamptic).

Laboratory Findings. Urine: Sugar 4 plus, no acetone or diacetic acid present; specific gravity, 1.020. Kahn reaction, negative.

Blood Chemistry:

2.24.50—274 mg. per cent blood sugar
2.25.50—218 mg. per cent blood sugar
2.26.50—280 mg. per cent blood sugar
3. 1.50— 90 mg. per cent blood sugar

Roentgen Examination. A film (Fig. 1) shows an advanced single pregnancy in vertex presentation with no apparent abnormality. The fetal spine runs lengthwise toward the right side of the maternal abdomen. No overlapping of the sutures of the caput is noted. The next

FIG. 3. Case II. Anteroposterior view, supine position. Arrow demonstrates air in umbilical area.

FIG. 4. Case II. Anteroposterior view, erect position. Arrow demonstrates complete collapse of fetal spine.

film (Fig. 2), taken with the patient in the *erect* view, demonstrates a complete collapse of the spinal column of the fetus in the pelvis with an acute flexion apparent in the cervical region. This finding would indicate that the fetus is no longer viable and is considered the diagnostic sign.

Patient delivered a stillborn fetus, weight 5 pounds, on February 25, 1950. The total duration of labor lasted twelve hours. Labor was induced and a macerated fetus resulted, following an uneventful delivery. No placental or

FIG. 5. Case III. Supine view, anteroposterior projection.

cord anomalies were noted. She was discharged on March 2, 1950.

CASE II. Mrs. E. W., nurse, white aged thirty-four, was admitted to Mercy Hospital on October 19, 1950. Her past menstrual and medical history was negative. She was Rh negative and her father, Rh positive.

On October 16, she suddenly became aware that no fetal movement was present. She consulted her family physician who found no heart tones audible.

A roentgenogram taken on October 20 (Fig. 3) in the *erect* view revealed an advanced single pregnancy in vertex presentation. The fetal spine is noted running lengthwise to the left of the maternal spine. Suggestive gas shadows in the region of the umbilicus were noted. This verified the previously reported sign of Davidson.[1a]

On erect view, anteroposterior projection (Fig. 4), a complete collapse of the fetal skeletal structure is found. Consequently diagnosis of a dead fetus was made. The patient delivered a macerated fetus, weight 5½ pounds, after an uneventful labor.

Case III. (This case is presented through the kind cooperation and courtesy of Dr. John W. Little, Jr., Radiologist at St. Mary's Hospital, Decatur, Illinois.) Mrs. A. A., colored, aged twenty-four, was seen at a regular prenatal visit on March 21, 1950. At this time the referring physician had no difficulty in hearing the fetal heart. The following evening, the patient telephoned him to report that she was unaware of any fetal movement. He advised her to report to his office on the following day, and at this time he was unable to hear the fetal heart tones. Roentgenograms (Fig. 5 and 6) were taken the same afternoon, March 23, 1950. Here, too, the findings are similar. In the *erect* view (Fig. 6), one again notes the complete collapse of the fetal skeleton.

The patient ultimately delivered a nonviable fetus two weeks later.

Comment. The maintenance of any posture or attitude, albeit even a fetus, is accomplished by the steady contraction of a large group of skeletal muscles. With the onset of death, the electrical excitability and stimuli of the neuromuscular reflexes are lost. It is logical to conclude that the absence of tone will cause a complete relaxation and loss of the postural attitude. Consequently, the finding of this sign, collapse of the fetal spine in the erect view, is extremely valuable for it appears to be based on sound physiological doctrine.

Fig. 6. Case III. Erect view, anteroposterior projection.

SUMMARY

1. Three cases are presented, in which a diagnosis of intrauterine fetal death could be established only with roentgenograms taken of the patient in the erect position.

2. In all cases, Spalding's sign was conspicuous by its absence, as well as a list of other signs in the usual routine view. Erect views demonstrate the ease of diagnosis.

3. A brief review of the status and significance of roentgen diagnosis of intrauterine death with special reference to Spalding's sing is presented.

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Thirty-fourth Annual Meeting: Stevens Hotel, Chicago, Ill., June 8, 9 and 10, 1952.

EDITORIALS

NATIONAL BUREAU OF STANDARDS SEMI-CENTENNIAL 1901–1951

THE year 1951 marked the Fiftieth Anniversary of the establishment of the National Bureau of Standards. Created by an act of Congress on March 3, 1901, the Bureau is the principal agency of the Federal Government for fundamental research in physics, mathematics, chemistry, and engineering. Although the Bureau's activities are largely concerned with the physical sciences, it also recognizes the close interrelationship of the major fields of science which precludes the drawing of sharp lines of distinction. For example, considerable work is undertaken in biochemistry, biophysics, and medical physics, particularly projects relating to materials, processes and instrumentation in these fields.

The history of the National Bureau of Standards actually extends back to the Constitution which gave cognizance of weights and measures to the federal government; the immediate antecedent of the Bureau was the Office of Weights and Measures created by Congress in 1830. However, it was not until the close of the last century, at which time American industry and science was beginning to stand on its own feet, that there was a recognized need for a major national physical laboratory similar to those already established in England and Germany. The problems relating to fundamental standards of science were of such a nature that they could not be left to the individual states. It was recognized as essential that a study of physical constants, the properties of materials, and methods and instruments of measurement called for a laboratory that would uniformly serve the entire nation. Particularly, in the case of industry, there was great need for the establishment of fundamental standards of measurement and ready access to facilities for the calibration of industrial and laboratory working standards. At the present time, practically all of the working standards used in research laboratories and in industry are calibrated in terms of the national standards of physical measurement that the Bureau maintains. Similarly, a large proportion of the standards in the medical and biophysical field relate directly or indirectly to standards maintained at the Bureau. To keep abreast of scientific and technological progress, it is essential that the Bureau carry on the necessary research leading to improvement in such standards and related methods and instruments. New standards, new methods and new instruments in keeping with the demands for greater precision and in the opening up of new fields of science are likewise objects of research.

The scope of the National Bureau of Standards' work is suggested by the names of its 15 divisions: electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, radio propagation, and missile development. The divisions in turn consist of several sections each—totaling 108—organized as logical units of the divisions. In addition to laboratory work, the Bureau, by virtue of its staff and facilities, is called upon to render scientific advisory services to the Government and

industry. Its participation in the activities of scientific and engineering societies and bodies, both nationally and internationally, is necessarily extensive and varied.

With a staff numbering about 4,000 people of whom about half are professionally trained scientists and engineers, the Bureau's main laboratories are centered in the Washington area. In addition, however, new branch laboratories are now being established, one in Corona, California, and one in Boulder, Colorado, to better serve the regions more distant from Washington. There are also some nineteen field stations maintained in this country and throughout the world: the Institute of Numerical Analysis in Los Angeles, twelve radio propagation field stations, six test and inspection stations, and two ordnance proving grounds.

To the scientist, the National Bureau of Standards probably appears as the scientists' laboratory, because he is familiar with its work on constants of nature, physical properties of basic materials, fundamental standards of measurement, and methods and instruments of measurement. The engineer is familiar with developmental aspects of its work, calibration services, and such activities as structural engineering. The public sees the Bureau as custodian of the national standards of weights and measures. The military see the Bureau as a successful inventor and developer of weapons. In World War II it played a key role in the atomic bomb project and developed the only successfully used, completely automatic guided missile, as well as the proximity fuse for non-rotating projectiles.

Of particular interest to medical circles has been the Bureau's activities relating to the field of radiology. In the middle 1920s, deep roentgen therapy was beginning to become an important tool in radiology. At that time, there was wide disagreement between the standards and the methods of measurement of roentgen rays. Through the interests and urging of the radiological organizations of this country, Congress specifically initiated a program in radiological physics at the National Bureau of Standards in 1926, just at the halfway mark of the Bureau's career. Initially, its basic object was to study the various methods and proposals relating to radiation standards. Subsequently, it became necessary to extend these standards into the higher energy fields as accelerating voltages on roentgen-ray tubes began to approach and finally pass the million mark. Within the last few years, it has become necessary to carry the research and development program into the field of radioactive isotope standards. With the present growth in the use of radioactive isotopes, it would seem that many years of work lie ahead in this field before the needs of radiology and industry can be fully met.

Starting with a staff of two persons in one room, this radiological program now occupies two major buildings, parts of several others, and has a staff of nearly one hundred persons of whom two-thirds are specially trained in the radiological physics field. Its program covers a wide spectrum of activities. At one end is the group working on pure radiological theory and the fundamental concepts of radiation dosage. At the other end is the group working on the development of specific roentgenologic equipment to be used by our military forces. In between lie the numerous associated problems including high energy radiation standards, the study and calibration of radiological instruments for civil defense and military services, the development of radiation safety codes and practices, and basic research in the penetration of radiation through matter.

An anniversary of an institution is an appropriate time to focus attention on its people. Whatever the reputation and achievements of the Bureau, they belong to the members of the staff, who have contributed much to science and to the nation. Their record is to be found in the thousands of research papers and reports of the past fifty years. It is that record which ultimately describes the institution, reveals its character, and establishes its value.

ADDITION TO THE TITLE OF THE JOURNAL

FOLLOWING the formation of the American Roentgen Ray Society in 1900, the annual meetings were published in the form of Transactions. By 1906 the Society had grown to such proportions, not only as shown in the increase of its membership but also in the number of papers that were being presented at the annual meetings as well as additional papers that were submitted to the Transactions for publication, that it was decided to establish a quarterly journal of roentgenology. Therefore, in 1906 there was established a quarterly publication known as The American Quarterly of Roentgenology. This quarterly journal was later expanded in 1913 to a monthly publication and its name changed to The American Journal of Roentgenology. With the formation of the American Radium Society the Journal became also the official organ of that Society and consequently its name was again changed to its present title; namely, The American Journal of Roentgenology and Radium Therapy. Under this title the Journal has continued to be published over the years.

Recognizing the importance of radioisotopes and the rapidity with which they have been employed within recent years, not only in diagnostic procedures but also as therapeutic agents, it was thought wise to incorporate in the title of the Journal an additional term which would also connote the Journal's interest in atomic medicine; and as a result of this decision the Executive Council has unanimously consented to a change in the title of the Journal to include Nuclear Medicine. Consequently The American Journal of Roentgenology and Radium Therapy will be known and published in the future under the title The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine. The format of the Journal's cover, however, remains unchanged except for the addition of Nuclear Medicine. The publisher, Mr. Charles C Thomas, has elsewhere in this issue of the Journal called attention to the official change in the Journal's title.

EDWARD PAUL McNAMEE
1890–1951

THE many friends of Dr. Edward Paul McNamee will be grieved to hear of his death. Dr. McNamee was born in Butler, Pennsylvania, on June 28, 1890. He was graduated from the University of Pennsylvania School of Medicine in 1913, and following an internship in the Presbyterian Hospital in Philadelphia, he opened his office in Cleveland for the general practice of medicine. His practice was interrupted by World War I, at which time he was trained at the U. S. Military School of Roentgenology and then sent on active duty in France in several hospitals of the

Third Division. On his return to Cleveland he established the radiological department at St. Alexis Hospital where he served until his death. He also carried on a busy office practice in downtown Cleveland. He was very active in many organizations in general medicine: a member of the Cleveland Academy of Medicine where he served six years on the Board of Directors; President of the Ohio State Medical Society; member of the House of Delegates of the American Medical Association; Fellow of the American College of Physicians and a member of a committee of five, appointed by Governor Lausche, to attend a course at Western Reserve Medical School in the therapy of atomic bomb injuries. In his chosen specialty he met with wide popularity. He was a charter member of the Cleveland Radiological Society, serving on many of its committees, acting as its Secretary in 1925 and 1926, and its President in 1926 and 1927; Radiological Society of North America 1920, on its Board of Directors from 1944 to 1947, and its President in 1929, its Vice-President in 1949 and currently Chairman of its Commission on Legislation and Public Policy.

He was active socially, belonging to the Cleveland Athletic Club, the Clifton Club and the Westwood Country Club where he was an ardent (and good) golfer.

He died on July 8, 1951, at the age of sixty-one, after a rather brief illness. "Mac" will be missed by his many colleagues in medicine and a wide group of social friends outside the field of medicine.

DAVID STEEL, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shamrock Hotel, Houston, Texas, September 23, 24, 25 and 26, 1952.

American Radium Society
Secretary, Dr. J. E. Wirth, 635 Herkimer St., Pasadena 1, Calif. Annual meeting: Stevens Hotel, Chicago, Ill., June 8, 9 and 10, 1952.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois. Annual meeting: Palmer House, Chicago, Ill., February 8, 1952.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Building, Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. J. D. King, 35 Linden Ave., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. B. D. Braun, 6 N. Michigan Ave., Chicago 2, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. W. P. Stampfli, 1933 Pearl St., Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. J. C. Cook, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. Nelson T. Pearson, 1109 Huntington Bldg., Miami, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Americus, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Greater Miami Radiological Society
Secretary, Dr. T. M. Berman, 350 Lincoln Rd., Miami Beach, Florida. Meets last Wednesday of each month at 8:00 P.M. at Veterans Administration Regional Office

Houston Radiological Society
Secretary, Dr. F. M. Windrow, 1205 Hermann Professional Bldg., Houston, Texas. Meets fourth Monday each month.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society.

Kansas Radiological Society
Secretary, Dr. Charles M. White, 3244 E. Douglas, Wichita 8, Kan. Meets annually with State Medical Society.

Kentucky Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Marcus Wiener, 1430 48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. John B. Hamilton, 210 N. Central Ave., Glendale 3, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Maine Radiological Society
Secretary, Dr. C. F. Miller, Central Maine General Hospital, Lewiston, Maine.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
President, Dr. Horace W. Porter, 505 Wildwood Ave., Jackson, Mich.

MID-HUDSON RADIOLOGICAL SOCIETY
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, 572 Lowry Medical Arts Bldg., St. Paul 2, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

MISSISSIPPI RADIOLOGICAL SOCIETY
Secretary, Dr. John W. Evans, 621 High Street, Jackson 2, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. R. W. Blanchard, 1216 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 P.M. at Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. L. L. Robbins, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Irving Schwartz, 45 E. 66th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY
Secretary, Dr. John F. Roach, Albany Hospital, Albany, N. Y. Meets on the second Wednesday of October, November and March at the University Club, Albany. Annual meeting in June to be announced.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB
Secretary, Dr. G. A. Fricker, Sacramento County Hospital, Sacramento, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Willis S. Peck, 2001 Collingwood Blvd., Toledo, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Brown, 21st & Xanthus, Tulsa 4, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting: Bedford Springs Hotel, Bedford, Pa., May 16 and 17, 1952.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. G. P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday each Month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. E. J. Euphrat, 3500 Fifth Ave., Pittsburgh 13, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Richard B. Hanchett, 705-6 Medical Arts Bldg., Baltimore, Md. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Fred. Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA
Secretary, Dr. U. V. Wilcox, 915 Nineteenth St., N. W., Washington 6, D. C. Meets Medical Society Library, third Thursday of January, March, May and October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI
Secretary, Dr. Lee S. Rosenberg, Jewish Hospital, Cincinnati 29, Ohio. Meets first Monday each month, October through May.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. Nicholas G. Demy, 912 Prospect Avenue, Plainfield, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

RICHMOND COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. George Gamsu, 191 S. Goodman St., Rochester, N. Y. Meets monthly on last Monday from September through May, 8:00 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. D. S. Bottom, 510 S. Kingshighway, St. Louis, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Tuesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH BAY RADIOLOGICAL SOCIETY
Secretary, Dr. Ford Shepherd, 526 Soquel Avenue, Santa Cruz, Calif. Meets second Wednesday each month.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. Henry E. Plenge, Spartanburg General Hospital, Spartanburg, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga,

Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Meets Houston, Texas, January 18 and 19, 1952.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. R. C. Kiltz, 705 Medical-Dental Bldg., Everett, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

Wisconsin Radiological Society
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. M. A. Sisson, 450 Sutter St., San Francisco, 8, Calif. Meets January to July, Lane Hall, Stanford University Hospital; July to December, San Francisco Hospital.

Cuba, Mexico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86 Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Sectetary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. R. deG. Burnard, 170 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179 B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro, Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Alberto Torres Focke, Av. 34, No. 17–34, Bogota, Colombia. Meets last Wednesday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^{e}, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Roentgen-Gesellschaft
Honorary President, Prof. Dr. F. Haenisch, Wentzelstrasse 14 I, (24a) Hamburg 39, Germany. Meets annually in different towns.

Societa Italiana dr Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

FOURTH ANNUAL MID-WINTER RADIOLOGICAL CONFERENCE

The Fourth Annual Mid-Winter Radiological Conference sponsored by the Los Angeles Radiological Society will be held at the Ambassador Hotel, Los Angeles, California, on Saturday and Sunday, February 23 and 24, 1952. Reservations for the meeting and banquet can be obtained by writing Dr. Roy W. Johnson, 1407 South Hope Street, Los Angeles 15, California. An informal banquet preceded by cocktails will be held at the Ambassador Hotel on Saturday evening, February 23, 1952.

The Conference fee is $20.00; the banquet, $5.00. Non-radiological colleagues who may be interested in any of the meetings are invited to attend and should send in reservations.

The following program has been arranged:

Saturday Morning

9:00 A.M. Registration

10:15 A.M. Welcoming Address. President, Los Angeles County Medical Association.

Roentgenological Examination of the Small Intestine. Dr. Kenneth S. Davis, Los Angeles, Calif.

The Possibilities and Limitations of Roentgen Diagnosis of Diseases of the Chest. Dr. Leo G. Rigler, Minneapolis, Minn.

Saturday Afternoon

1:30 P.M. Applications of Sectional Radiography. Dr. Wendell G. Scott, St. Louis, Mo.

Results of Treatment of Cancer of the Larynx. Dr. L. Henry Garland, San Francisco, Calif.

Role of the Radiologist in Radiological Defense. Dr. Stafford L. Warren, Los Angeles, Calif.

Saturday Evening

6:00 P.M. Cocktails. Compliments of the Commercial Exhibitors.

7:00 P.M. Annual Banquet.

Sunday Morning

9:30 A.M. Pitfalls in Contrast Myelography. Dr. John D. Camp, Los Angeles, Calif.

The Early Diagnosis of Cancer of the Stomach. Dr. Leo G. Rigler, Minneapolis, Minn.

Clinical Studies with Radioisotopes. Dr. John H. Lawrence, Berkeley, Calif.

Sunday Afternoon

1:30 P.M. Newer Cholecystopaques in Oral Cholecystography. Dr. Wendell G. Scott, St. Louis, Mo.

Roentgenologic Phrenology or Roentgenologic Aspects of Tumors of the Scalp and Skull. Dr. John D. Camp, Los Angeles, Calif.

AMERICAN COLLEGE OF RADIOLOGY

The annual meeting of the American College of Radiology will be held on February 8, 1952, at the Palmer House, Chicago, Illinois.

ALABAMA RADIOLOGICAL SOCIETY

At the annual meeting of the Alabama Radiological Society held in April, 1951, the following officers were elected for the year 1951–1952: *President*, Dr. W. D. Anderson, Tuscaloosa; *Vice-President*, Dr. C. S. Stickley, Montgomery; *Secretary-Treasurer*, Dr. J. A. Meadows, Jr., Birmingham; *Member of the Executive Committee*, Dr. M. Eskirdge, Mobile; *Counselor to the American College of Radiology*, Dr. John Day Peake, Mobile.

ILLINOIS RADIOLOGICAL SOCIETY

At a recent meeting of the Illinois Radiological Society the following officers were elected for the year 1951–1952: *President*, Dr. William DeHollander, St. John's Hospital, Springfield, Ill.; *Vice-President*, Dr. Gordon M. Perisho, Quincy Clinic, Quincy, Ill.; *Secretary-Treasurer*, Dr. Stephen L. Casper, Physicians & Surgeons Clinic, Quincy, Ill. Meetings are held three times a year.

LOS ANGELES RADIOLOGICAL SOCIETY

At the annual election of the Los Angeles Radiological Society in November the following officers of the Society were elected: *President*, Dr. Harold P. Tompkins; *Vice-President*, Dr. Richard Smith; *Secretary*,

Dr. John B. Hamilton; *Treasurer*, Dr. M. M. Haskell.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

At a recent meeting of the Northeastern New York Radiological Society, the following officers were elected: *President*, Dr. Orville Henderson, Troy; *Vice-President*, Dr. Joseph Rosenstein, Lake Placid; *Secretary-Treasurer*, Dr. John Roach, Albany.

OHIO STATE RADIOLOGICAL SOCIETY

The annual meeting of the Ohio State Radiological Society was held at the Fort Hayes Hotel in Columbus, Ohio, May 25 and 26, 1951. The meeting was successful and well attended. The newly elected officers for the year 1951–1952 are as follows: *President*, Dr. Donald D. Brannan, Cleveland; *Vice-President*, Dr. Edward C. Elsey, Cincinnati; *Secretary-Treasurer*, Dr. Willis S. Peck, Toledo.

STUDY OF "CANCER EYE" IN BOVINES

A committee composed of cattlemen, cancer researchers and researchers in animal science has been formed to study the problem of "cancer eye" in bovines. The committee has as its purpose the initiation and coordination of research in "cancer eye" of cattle. It had its organizational meeting at The University of Texas M.D. Anderson Hospital for Cancer Research, Houston, Texas, on September 25. Research on several aspects was planned. Further information may be obtained from William O. Russell, M.D., 2310 Baldwin Street, Houston 6, Texas.

FELLOWSHIP IN PEDIATRIC ROENTGENOLOGY

Applications are being accepted for the Fellowship in Pediatric Roentgenology in the Children's Hospital of Cincinnati for the year beginning July 1, 1952. The Fellowship is administered by the Department of Roentgenology of the University of Cincinnati for work and study in the Department of Roentgenology in the Children's Hospital. Two years' prior training in Radiology in an approved institution is required. For further particulars, communications should be addressed to Dr. Frederic N. Silverman, Director, Department of Roentgenology, Children's Hospital, Cincinnati 29, Ohio.

GRADUATE FELLOWSHIPS IN RADIOLOGICAL PHYSICS

The Oak Ridge Institute of Nuclear Studies is now receiving applications for Atomic Energy Commission Graduate Fellowships in Radiological Physics for the 1952–1953 school year.

The fellowships are awarded for study at two training centers: one at the University of Rochester in cooperation with Brookhaven National Laboratory, and the other at Vanderbilt University in cooperation with Oak Ridge National Laboratory. In both cases, the final three months of the fellowship will be spent at the national laboratory. Appointments are made for one year for specialized training in radiological physics.

The annual basic stipend is $1500. An additional $500 is allowed for a wife and $250 for each of two dependent children, making a maximum stipend of $2500 annually. University tuition and fees will be paid by the Oak Ridge Institute of Nuclear Studies.

Applicants to be considered must hold an undergraduate degree at the time of entering the fellowship period, preferably with a major in physics, chemistry or engineering and a minor in mathematics, biophysics or similar fields. Fellows must be citizens of the United States and must receive security clearance in accordance with existing laws.

Application blanks and additional information may be obtained from the heads of science and engineering departments of colleges and universities or from the University Relations Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn. Applications must be in

the hands of the Institute by March 1, 1952.

NATIONAL BUREAU OF STANDARDS PHOSPHORUS 32 AND IODINE 131 SOLUTION STANDARDS

The National Bureau of Standards has now added standard solutions of phosphorus 32 and iodine 131 to its list of standard samples available for general distribution to investigators in physics, chemistry, medicine, and industry. The program was initiated on a limited basis early in 1946 and is now expanded to operate on a periodic schedule. P^{32} is distributed during March and September, and I^{131} during January and June. These new standards bring to a total of nine the number of radioactive standards distributed or calibrated by the National Bureau of Standards.

The radioactive isotopes P^{32} and I^{131} have been employed extensively for diagnosis and therapy in brain surgery, leukemia and other types of cancer. In the early use of these "tagged" atoms, variations in the results obtained by different laboratories amounted to as much as 100 and 200 per cent of the accepted value. It is primarily for this reason that the National Bureau of Standards has extended its efforts towards standardization. The procedure that has been established will now permit the duplication of research results at different laboratories and installations.

The P^{32} and I^{131} standards consist of a flame-sealed sterilized glass ampule containing the active isotope in approximately 3 milliliters of dilute carrier solution. The exact disintegration rate per milliliter as of the zero date is noted and is roughly 100,000 disintegrations per second per milliliter (dps/ml). These standards, because of their low activity, are exempt from Federal regulations regarding the possession, use, and transfer of radioactive materials.

The NBS solution standards can be obtained by writing at any time to the Radioactivity Section, National Bureau of Standards, Washington 25, D. C., or by completing an order form which is circularized in advance of the distribution. All requests received will be filled at the nearest distribution date. The fee for this service is $5.00. Remittances should be made payable to the National Bureau of Standards. Federal and State agencies are exempt from payment. In addition, a very limited supply of I^{131} and P^{32} solution standards will be kept on hand at all times for immediate distribution to laboratories for emergency purposes only.

The other NBS standards include radium gamma-ray solution standards, radium solution for radon calibrations, radium D+E beta-ray standards, calibrated radioactive ore samples, cobalt 60 beta- and gamma-ray solution standards, carbon 14 beta-ray solution standards, and neutron flux standards. A complete price list, with directions for ordering, can be obtained upon request from the Radioactivity Section, National Bureau of Standards, Washington 25, D. C.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

ROENTGEN MANIFESTATIONS OF PANCREATIC DISEASE. By Maxwell Herbert Poppel, M.D., F.A.C.R., Associate Professor of Clinical Radiology, New York University-Bellevue Medical Center; Associate Roentgenologist, New York University Hospital; etc. Cloth. Price, $10.50. Pp. 389, with 166 illustrations and 14 tables. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1951.

The pancreas has thus far resisted most attempts at direct visualization on the roentgenogram. For this reason attention has been focussed on indirect demonstration through the effect the pancreas has on those adjacent structures which it is possible to demonstrate on films. Calcium deposits or large masses within the pancreas can be demonstrated directly, but in most instances information is obtained only from indirect evidence. This leads to the necessity of a complete discussion of the appearance of the stomach, the duodenum, the gallbladder and its ducts, the small intestine, the colon, the kidneys, and the liver in the presence of pancreatic disease, in addition to a description of the fundamental pancreatic abnormality. The author has given this rather complicated subject fairly complete treatment.

The text material is very well organized and subjected to clear exposition. After describing the normal variations and congenital abnormalities of the pancreas and duodenum, the author discusses the surprisingly numerous avenues of approach to the pancreas available to the roentgenologist. In addition to describing the usual means of examination, the author wisely stresses the value of views made in right and left lateral recumbency with the central ray anteroposterior in direction, and views made transabdominally with the patient supine. Each of the various affections of the pancreas is then taken up in detail: calcareous disease, tumors, inflammatory changes, pancreatic exocrine insufficiency including fibrocystic disease, and diseases in which the pancreas is secondarily involved, as in retroperitoneal lymph node enlargement, perforating peptic ulceration, and aneurysm. Following this is a consideration of differential diagnosis, and this chapter is particularly complete. Each of the roentgen manifestations which might lead one to suspect a pancreatic lesion is discussed in detail, with careful differentiation of pancreatic disease from lesions of other origin.

An outstanding feature which is so necessary for a text of this type is the large number of excellent illustrations, which are well reproduced, well captioned, and are large enough to display the pertinent structures. Many of the illustrations occur in series, and instead of being crowded into composites, they are on consecutive pages, to permit greater enlargement. In contrast with the uniformly high quality of the illustrations, there are two elements which detract somewhat from the author's style. The orderly nature of the presentation leads to division and subdivision of the text into sections, each with its own heading and sometimes consisting of only a sentence or two. Also, there is frequent reference in the text to previous workers by name rather than relegation of the source to footnotes. This latter may be a manifestation of the author's generosity in expressing indebtedness.

The book is written for the radiologist. Others may study with profit the large number of approaches available in the demonstration of pathological pancreatic change and what may be gained from each method of examination, but the book will be of most significant value to the roentgenologist in search of evidence of pancreatic disease. In some sections the author speaks directly to the radiologist. There is a plea for a thorough investigation of the patient instead of merely a thorough perusal of the films. Clinical and laboratory data are correlated with the roentgen findings throughout, and the physiological and pathological bases for the changes shown on the films are described. An interesting inclusion is a series of outlines for the analysis of masses in various portions of the pancreas, and these serve to prevent overlooking any bit of information or evidence which might be available, adding to

the practicality of the book. In a sense, they are a short review or check-list of the points made in the respective chapters. In one section there are categorical remarks concerning the terminology appropriate to the body and the conclusion of the roentgen report. Throughout, the author is constantly striving to increase the quantity and enhance the quality of information made available through the radiologist to the referring physician. The book has much to offer anyone who examines the abdomen, either clinically or, more particularly, roentgenographically.

E. F. Lang, M.D.

Bronchography. By Eelco Huizinga, M.D., and G. J. Smelt, M.D., Department of Oto-Rhino-Laryngology, University of Groningen. Cloth. Price, hfl. 39.–. Pp. 270, with about 150 illustrations. Aan den Brink-Assen, Netherlands: Van Gorcum & Comp. Ltd. (G. A. Hak & H. J. Prakke), 1949.

At the Groningen University Clinic, lipiodol bronchography has been performed by the authors (otolaryngologists) for many years, and they have drawn from their experience to present this monograph of bronchography. The opening chapters contain detailed discussions of the historical aspects of bronchial anatomy and the newer nomenclatures of bronchial architecture. An interesting discourse on the physiology of the bronchial tree is then presented. Of particular value is the extensive section describing the roentgen anatomy of the bronchi as seen in the various projections employed commonly in bronchography.

Illustrations and discussions of the three classical abnormalities of the bronchi, as seen by bronchography—dilatation, displacement, and stenosis—are presented, and typical and unusual case studies serve to emphasize the necessity for systematized thinking in the interpretation of films showing these pathologic features.

Of aid to the beginner in the field of bronchography is the final chapter of the work which concerns the authors' bronchographic technique, which differs little from that in use generally in this country, except that the use of roentgenoscopic guidance during the filling of the bronchi with the opaque medium is disdained. Although oblique films are deemed essential, stereoscopic views are not mentioned.

A complete bibliography of pertinent literature is appended; an index to the volume is lacking. In general, the illustrations, although positive prints, are good, but the explanatory text for each illustration is often spread over several pages.

This small volume is highly recommended as a concise and accurate textbook of bronchography.

Harold Fulton, M.D.

La pratique stomatologique. Publiée sous la direction du Dr. Chompret. IX. Radiographie bucco-dentaire et agents physiques en stomatologie. Par P. Bertrand, M. Dechaume, et G. Lacronique. Deuxième édition. Cloth. Price, 1800 fr. Pp. 523, with 568 illustrations. Masson et Cie., 120, boulevard Saint-Germain, Parie 6e, France, 1950.

This work of a little more than five hundred pages is an excellent manual on dental and buccal roentgenologic practice. Introductory chapters on the physics of radiation as applied to this field are followed by detailed explanation of the technical factors, placing of the patient, direction of the rays to dissociate the roots of the teeth. Then follow sections with excellent detailed illustrations on roentgenography of the upper and lower jaw, and with many pages on various pathologic lesions in the mouth and jaws. The illustrations are mostly very satisfactory and well reproduced. There is an excellent section on sialography with numerous reproductions of films. The last 125 pages deal with radium, roentgen-ray and short wave therapy as applied to the buccal and dental regions. This is an excellent book for those who read French.

James T. Case, M.D.

Das Adenocarcinom des Collum Uteri—histologische, klinische und therapeutische Ergebnisse. By Dozent Dr. Limburg and Dr. Klaus Thomsen. Paper. Price, DM 6.80. Pp. 87, with 39 illustrations. Georg Thieme, Diemershaldenstrasse 47, Stuttgart, Germany, 1949.

The authors, who are on the staff of the Women's Clinic of the University of Hamburg, discuss in this monograph the histopathological and clinical aspects of adenocarcinoma of the cervix uteri as well as the therapeutic results. In a relatively small space they have succeeded in condensing an impressive amount of information. Within the scope of a review, only the highlights of their presentation can be covered. To those with a reading knowledge of

German the perusal of the original is highly recommended; the 25 tables alone distributed throughout the text are worthy of study.

The incidence of adenocarcinoma of the cervix varies widely as shown by a review of the literature: 1–13.5 per cent of all cancers of the cervix. In the authors' own 3,057 cases of female genital tract malignancies observed during 1919–1947 it amounted to 65 patients, or 2.1 per cent.

Macroscopically there is no difference between squamous cell carcinoma and adenocarcinoma of the cervix and consequently there is no difference noted on pelvic examination; the distinction between the two types has to be made microscopically. As far as the prognosis is concerned, it is less favorable in adenocarcinoma, not because of histopathological differences, but because there is a longer symptom-free period, a tendency to metastasize early and microscopic extension of the tumor tissue which therefore escapes the palpating finger.

In their classification, the authors differentiate macroscopically exophytic, endophytic and ulcer and crater forming types; microscopically there are mature and moderately mature, immature, special forms (papillary, Gartner's ductules, mucinous), and also adenocarcinoma with squamous cell metaplasia. "Adenoma malignum," a term which is often used in this country, is considered a misnomer by the authors; they could find only 7 proved cases in the entire literature.

The age of the series of patients analyzed varied from thirty to seventy-six years with an average of fifty-seven. The cardinal symptoms were bleeding, discharge, pain and loss of weight, with a duration of from six days to two years; half of the patients reported for examination within three months after the onset of symptoms. It is noted that only 2 of the 65 patients were nulliparas. The grouping used conforms to that of the League of Nations stages. Twenty-six patients belonged to Stage I; 5 were irradiated and 21 operated on. Fourteen patients belonged to Stage II; 9 were irradiated and 5 operated on. Twenty cases belonged to Stage III; 16 were irradiated, 3 were operated on and 1 was treated by roentgen rays alone. Of 5 cases in Stage IV, 3 were irradiated and 2 were treated only symptomatically. The surgical procedures used in a total of 29 cases consisted of the Wertheim operation in 20 and of other methods (total extirpation) in 9. The operative mortality was 10.4 per cent (3 deaths), 1 in Stage III and 2 in Stage II. Nineteen patients received postoperative roentgen therapy and 3 had preoperative radium therapy. The five year survival rate based on the material studied between 1919 and 1943 was 40.9 per cent. Radium therapy was used in 33 cases, as mentioned above, and only 1 case received roentgen therapy alone. Available for treatment were 45 mg. of radium—190 mg. at the present—placed in 1 mm. aluminum tubes; the total dose of 6,000 to 7,200 milligram hours was administered in four sittings of twenty hours each at weekly intervals, the screens being packed in the vagina, in the cervical canal and in the uterine fundus. The authors could find no correlation between the dose of radiation and the length of survival. In their series they achieved a five year freedom from recurrence of 21.4 per cent. They could not detect any evidence that adenocarcinoma of the cervix is more radioresistant than squamous cell carcinoma, as demonstrated by the fact that survival rate of all cases of squamous cell carcinoma was 29.8 per cent as compared with 28.3 per cent in the cases of adenocarcinoma.

The diagnosis and differential diagnosis are discussed in a separate chapter. Illustrative case histories are presented and photomicrographs of biopsies taken from selected lesions are shown in the text. It appears that mature forms have a more favorable prognosis than the immature forms; 70 per cent of the former are operable while only 50 per cent of the immature forms are.

In conclusion, the authors state that in view of their experiences outlined in this monograph they intend to continue with what they call the "elective" method of therapy: Operation will be performed in all early stages since it offers a five year survival of 49.5 per cent. This is an average percentage based on reports published by six German and one Austrian clinic. However, in Stage III of the disease radium is definitely of promise, as borne out by their statistics.

E. A. POHLE, M.D.

SELECTED PAPERS FROM THE ROYAL CANCER HOSPITAL AND THE CHESTER BEATTY RESEARCH INSTITUTE. Volume V. Paper. Price, 16s. Pp. 483, with numerous illustrations. Published by order of the Board of Governors of the Royal Cancer Hospital, Fulham Road, London, S.W.3, England, 1945–1947.

This volume contains sixty-two articles by forty-eight authors from the above mentioned institutions. The subject matter varies from the Presidential Address of Dr. D. W. Smithers on "The Radiotherapist and the Cancer Patient" to the "X-ray Measurement of the Diameters of the Living Eye." The volume is replete with studies of clinical aspects of therapeutic radiology and problems dealing with radiologic physics. At least twenty-eight of the articles deal with carcinogenic agents and other basic biologic aspects of the cancer problem. There are no papers on the strictly diagnostic aspects of roentgenology as would be expected. The volume is an excellent example of the coordinated activities of clinician, physicist and research worker when dealing with the over-all subject of malignant disease.

H. Dabney Kerr, M.D.

Progress in Biophysics and Biophysical Chemistry. Volume 1. Editors: J. A. V. Butler, Chester Beatty Research Institute, Royal Cancer Hospital, London; and J. T. Randall, F.R.S., Wheatstone Professor of Physics in the University of London at King's College. Cloth. Price, $6.80. Pp. 279, with numerous illustrations. Academic Press, Inc., Publishers, 125 East 23rd Street, New York, New York, 1950.

Up to 1940 only about ten books were published which dealt with subjects from the borderline fields of biology and physics. Since then a great number of texts on such subjects have appeared, among them such comprehensive collaborative efforts as "Medical Physics I" (1944), "Advances in Biological and Medical Physics" (1948), "Medische Physica" (1949), "Applied Biophysics" (1949), and "Medical Physics II" (1950).

The present volume is an addition to this ever growing literature on a field which continually grows in importance. The editors emphasize that it is impossible in a single volume to deal at length with more than a few topics and that they intend to publish further reports at regular intervals. The subject matter is presented by nine scientists in nine well balanced chapters. These deal with the application of physical methods to the study of characteristic physiological molecules and of living structures such as nerve and muscle fibers. Some of the chapter headings may illustrate the mode of attack of these problems: "Properties of Solutions of Large Molecules," "Fundamental Structures in Biological Systems," "Bioelectric Potentials," "Phase-Contrast Microscopy," "Local Refractometry." Of special interest to the radiologist is the excellent report by E. Engström of the Stockholm Carolinska Institutet on the use of very soft roentgen rays in the assay of biological material such as the determination of the mass of cell structure and the quantitative evaluation of its composing elements. In another chapter, J. F. Loutit of the British Atomic Energy Research Establishment in Harwell presents calculations of the maximal permissible amounts of any radioactive isotope within the body. Interesting roentgen-ray diffraction studies of polypeptides and proteins are discussed by K. M. Rudall; G. Oster writes on scattering of roentgen rays by solutions of protein. All reviews are well written and excellently illustrated. They have comprehensive reference lists. One unusual and somewhat annoying feature of these reference lists is the omission of publishers and editors of the books listed.

Otto Glasser, Ph.D.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. LEUCUTIA, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

HEAD

SCHÜLLER, A. A short review of cranial hyperostoses. *Acta radiol.*, Oct.–Nov., 1950, *34*, 361–373.

The author groups the cranial hyperostoses from an etiological standpoint as follows:

1. *Congenital hyperostosis.* (a) In marble bone disease (Albers-Schönberg), the base of the skull is usually sclerosed. Rarely are hyperostotic changes noted in the entire cranium. (b) In a minority of the cases of craniostenosis the frontal and parietal bones are symmetrically thickened (usually these skulls are of normal thickness or thinner than normal). (c) Caput natiforme congenitum is a rare condition in which there is thickening of the cranial wall except along the sagittal suture. Therefore, a deep furrow between the prominences of the parietal regions is formed. (d) Fibrous dysplasia causes an asymmetrical thickening in the frontal region which usually starts during childhood and is progressive. The sclerosis extends along the floor of the anterior fossa encroaching on the frontal sinuses and orbits with resultant disfigurement. (e) The author has seen only one case of osteopoikilosis in which the skull was involved. (f) Racial hyperostosis is exemplified in the thick dense skull of the Negro.

2. *Compensatory hyperostosis.* (a) This may occur secondarily as a result of cerebral hypoplasia a good example of which is sclerosis of the cranial vault over a porencephaly. (b) Rarely the thickening involves the base of the skull as in Chiari's basal hyperostosis of idiots. (c) Another example of this form is seen in the thick hydrocephalic skull which occurs when there is a secondary shrinking of the "distended" brain from a restoration of normal flow of cerebrospinal fluid. (d) In Sturge-Weber's syndrome (calcifications of the cerebral cortex with facial angiomatous nevi) unilateral thickening of the cranium is present.

3. *Endocrine hyperostosis.* (a) In acromegaly the cranium becomes larger by eccentric apposition of bone. (b) The bony overgrowth in hyperostosis frontalis interna is seen in approximately 5% of all skulls. It occurs predominantly in women. The excess bone arises from the inner table on both sides lateral to the midline. (c) Osteitis fibrosa cystica generalisata (Recklinghausen) often produces a woolly looking skull due to new bone formation. An adenoma or hyperplasia of the parathyroids is usually the etiologic factor. (d) Hyperostosis cranialis gravidarum is the name for a thin layer of osteoid tissue which develops along the longitudinal sinus and the middle meningeal artery in the third month of pregnancy. It later forms bone (puerperal osteophyte).

4. *Dyscrasic hyperostosis.* (a) After treatment for rickets the bosselated skull will show undue thickening of the tables. (b) In advanced cases of renal rickets the skull may show a woolly thickening. (c) The chronic hemolytic anemias (erythroblastic, sickle cell and chronic hemolytic icterus) cause proliferation of the diploic layer of the skull with resultant thickening but osteoporosity. The "hair on end" appearance may result.

5. *Dystrophic hyperostosis.* (a) Hyperostosis of the skull occurs in one-third of the cases of Paget's disease. The cranial involvement may be the only one in the whole skeleton. The fully developed Paget cranium is at least fifteen years old.

6. *Inflammatory hyperostosis.* (a) In the late stages of tertiary syphilis a generalized thickening and sclerosis of the calvaria may be found. The hydrocephalus of syphilitic infants shows thick walls and a prominent frontal region (olympic forehead). (b) Destruction and sequestration of the cranial bones from chronic osteomyelitis may be followed during the healing stages by sclerosis of the cranial walls. (c) Xanthomatosis of the Hand-Schüller-Christian type may, in the healing stage, show hyperostosis. The roentgen picture of the skull may be similar to that seen in marble bones.

7. *Traumatic hyperostosis.* (The great majority of cranial fractures have no tendency to form callus.) (a) Pronounced cranial hyperostosis may develop in cephalhematomas of the newborn and of infants. That of the newborn usually disappears after weeks or months but occasionally hyperostosis or cyst formation may persist from the hematoma of the newborn or from the hematoma acquired during infancy or childhood. It may remain unchanged and symptomless throughout life. (b) Infantile subdural hematomas of long duration occasionally develop extensive bone formation.

8. *Neoplastic hyperostosis.* (a) Fifty per cent of adults are estimated as having an osteoma of the skull. They may protrude from the inner or outer table. (b) In tuberous sclerosis calcium deposits on the cortex may be superimposed by hyperostotic islands on the inner table and diploe. (c) Osteosarcoma of the skull usually produces a bony network. It may have its origin from the periosteum, the diploe or the dura. (d) Malignancies metastatic to the skull are infrequently osteoblastic. (e) Hemangiomas in the cranial walls are frequent. The striations in hemangiomas end at the outer table while in meningiomas they extend into the scalp. (f) A small enostosis of the calvaria may be the only roentgenographic sign of an extensive neoplasm of the meninges (meningioma). On the other hand, a thickening of the whole calvaria may be present when only a small meningioma on the convexity of the brain can be found.—*Mary Frances Vastine, M.D.*

SOMMER, FRANZ. Beitrag zur Sturge Weberschen Krankheit. (Contribution to Sturge-Weber's disease.) *Fortschr. a. d. Geb. d. Röntgebstrahlen ver. m. Röntgenpraxis*, Oct., 1950, *73*, 581–585.

This is a case report of Sturge-Weber's disease in a

twelve year old boy who has been observed by the author for many years and whose preliminary history was previously published (Sommer and Demoullin, *Paris méd.*, 1947, *49*, 560).

The boy was a normal delivery; his parents, brothers, and sisters were normal. One cousin has a hand sized nevus on the throat. At the age of four months, the mother first noticed that the patient had mild twitchings of the right hand and arm during feeding. These twitchings extended to the face and right leg. Attacks of temporary paralysis replaced the twitchings. The patient walked at the age of three years and spoke at the age of four. From three years of age the patient had episodes of dizziness with convulsions which were getting progressively worse, appearing more frequently and becoming gradually of longer duration. These episodes were associated with paroxysmal tachycardia. There was also progressive mental deterioration.

On physical examination at the age of twelve years, the patient was found to be overweight for about a year. A large portwine nevus involved the region of the left first trigeminus branch and extended to the mid nasal bridge and the entire left upper eyelid. A second nevus involved the mucosa of the left upper lip and hard palate (second branch of the trigeminus) and a third nevus, the size of a quarter, was present on the left buttock. The conjunctiva and the background of the left eye appeared deep red in color. The visual field examination of the left eye revealed a right-sided hemianopsia with a concentric narrowing of the left half of the visual field. The arm and leg showed spastic paralysis with a positive Babinski on the right side. The speech was slow and inarticulate.

According to the mother, a roentgen examination made at the age of two remained negative. In 1946 widespread calcified deposits were noted in the left cerebrum, becoming more extensive at the recent examination.

The author cites the different opinions regarding the pathogenesis of the changes in the brain. He concurs with those who believe that the alterations are due to atrophy of the cerebral convolutions secondary to hemangioma of the pia and not the result of congenital malformation of the brain. He concludes by suggesting early radiation therapy in an attempt to prevent the formation of the typical brain calcification.—*Salomon Silvera, M.D.*

Nachlas, N. Edward. Rhinolith as a cause of suppurative rhinitis. *New England J. Med.*, Jan. 4, 1951, *244*, 15–16.

Suppurative rhinitis complicating rhinolith is rare. In the past fifteen years only 3 patients have been admitted to the Massachusetts Eye and Ear Infirmary with rhinolith, and only 1 of these cases was complicated by rhinitis caseosa. The more common symptoms are unilateral nasal obstruction and discharge. The roentgenogram may aid in diagnosis, although many rhinoliths are radiolucent. Evidence of bone destruction may be found. If the rhinolith is entirely removed there is little tendency to recur. A case report is presented.—*D. S. Kellogg, M.D.*

Marks, K. L., and Turner, W. L. Carcinoma occurring in the sinuses of chronic osteomyelitis. *Brit. J. Surg.*, Oct., 1950, *38*, 206–209.

Having encountered 3 cases of carcinoma in the sinuses of chronic osteomyelitis within a year, the authors compared their experience with that of others reporting on this condition.

They agree that it is rare, giving no figures of their own but quoting Henderson and Swart (0.25 per cent in a series of 2,396 cases of chronic osteomyelitis) and McNally and Dockerty (0.23 per cent in a series of about 4,000 cases).

Though in the literature the commonest sites of the bone infection in order of frequency are the tibia, femur, and foot, all 3 of these cases were in the femur.

Enlargement of regional lymph nodes occurs in approximately two-thirds of all cases, but is usually due to chronic inflammation, rarely to metastasis. Radical amputation above the affected area offers an excellent prognosis.

The very low incidence of malignant degeneration in these sinuses and almost exclusive occurrence in individuals past middle age suggest that chronic irritation due to the long continued discharge of pus is not the only etiologic factor involved. The authors speculate upon the role of old age, diminished circulation, scar tissue, and constitutional carcinogenic tendency.—*George Cooper, Jr., M.D.*

Graham-Hodgson, Harold. Radiology of the infected temporal bone. *Proc. Roy. Soc. Med.*, Dec., 1950, *43*, 989–998.

The prime importance of the roentgen examination of the temporal bone is the information it yields as to the anatomical type of petrous bone involved. Roentgen evidence of infection is of secondary importance because in many cases it is only corroborative of the obvious clinical signs and symptoms.

Approximately 95 per cent of cases of chronic otitis media occur in diploetic or poorly pneumatized "infantile" mastoid. Acute otitis media may occur in connection with either the adult or infantile type of mastoid, but resulting acute mastoiditis is more apt to occur in the adult type since diploetic bone is more resistant to infection than the well pneumatized, freely connecting cells.

Diamant's investigations of approximately 1,000 persons over ten years of age (40 per cent had no ear symptoms, 60 per cent had acute or chronic otitis media) showed that the cell system varied normally from 0 to 30 sq. cm. with an average size of 12–13 sq. cm. The examination of patients with chronic otitis media showed an average cell system of 2.89 sq. cm. Diamant states that "if a cell system is found to exceed 16 sq. cm., one may assert that if infection

should occur it will not give rise to a permanent change in the tympanic membrane."

Mastoiditis, except in very rare cases, is not a disease entity in itself, but a sequel to infection of the middle ear. The logical approach to the problem would be roentgen examination of the path of infection, namely eustachian tube, petrous bone and middle ear and, finally, the mastoid process.

Roentgenographic Technique. Roentgenograms of the temporal bone can be made with standard technique; however, more satisfactory results are obtained with specially designed apparatus, *i.e.*, Law, Granger, Lysholm and Bullitt.

The author describes his technique for the submandibular vertex view, Towne's view, lateral oblique and posteroanterior oblique views. The lateral oblique roentgenogram is made with the head in the true lateral position with angulation of the tube 30° toward the feet and centered over the external meatus nearest the film. This view shows the anteroposterior extent of the mastoid cells as well as the pneumatization of the squamosa. It also shows the anterior wall of the lateral sinus, the temporomandibular joint, external meatus, the tegmen tympani and the antrum.

Roentgenological Interpretation

1. Acute otitis media in a cellular mastoid: In the earliest stages only a slight haziness of the periantral cells will be seen gradually spreading through the process. Later the walls become decalcified and indistinct. In many acute cases the submandibular vertical view may show some increased density of the petrous bone on the affected side.

In the lateral oblique view increased clarity of the sinus plate is a valuable sign in the early detection of acute infection. The Towne and submandibular vertical positions show slight clouding of the mastoid cells to good advantage. In the latter view the path of infection is also visible and cloudiness of the eustachian tube and middle ear on the affected side with consequent blurring of the outlines of the ossicles is noted.

2. Acute otitis media in the acellular or diploetic mastoid: In the poorly pneumatized or infantile type of mastoid, roentgen evidence of infection is difficult to detect if the examination is confined to the mastoid process alone. In the acellular mastoid, it is impossible to detect alterations in the usual views until actual bone destruction or sclerosis has occurred. However, study of the path of infection in the submandibular vertical view will show increased opacity of the involved petrous bone, cloudy eustachian tube and middle ear, and ill defined ossicles.

3. Chronic otitis media: This practically never occurs except in the poorly pneumatized infantile type of mastoid. The roentgen changes are fairly obvious, and are those of sclerosing osteitis. The bony walls of the middle ear are thickened and its cavity opaque. The ossicles become difficult to distinguish or disappear altogether. The petrous bone assumes an ivory-like density and the eustachian tube on the affected side usually shows a lack of aeration.

4. Complications of mastoiditis:

(a) Abscess formation. One or more cells may break down with coalescence of the cavities and formation of an abscess. Cholesteatomas must be considered in the differential diagnosis. They are fairly common and occur in the infantile type of mastoid. They originate in the attic and spread to the aditus and antrum. Abscesses are inclined to be peripheral and, while not common, they occur more frequently in the adult rather than infantile type of mastoid.

(b) Apical petrositis. Petrositis, an uncommon complication of acute otitis media, indicates an infection of the cell walls. It is associated with Gradenigo's syndrome—paralysis of the sixth cranial nerve and trigeminal neuralgia. The diagnosis is usually clinical rather than roentgenological. The first roentgenological sign is actual breakdown of the bony structure, with possible sequestration.

(c) Cholesteatoma. This is a common complication of chronic otitis media, and requires a low grade chronic infection and a mastoid process of the infantile type for its formation.

Dead cells accumulate in a pseudotumor which gradually increases in size as further dead cells are added to the mass. This mass originates in the attic and extends through the aditus into the mastoid antrum. When it completely fills the cavity it occupies, the bony walls are gradually eroded by the pressure of the tumor. Until this erosion is of appreciable extent the only roentgenographic evidence will be that of chronic otitis media. Negative findings on the roentgenogram do not rule out cholesteatoma.

Due to the slow growth, a protective zone of calcification occasionally forms around the periphery of the mass. The eroded area, which is less opaque than the surrounding bone, is usually smooth and round or oval in shape.

Early diagnosis is important because as erosion increases it may cause a labyrinthine fistula through the upper part of the posterior wall of the external auditory meatus or through the tegmen tympani into the middle fossa.

(d) Healed otitis media. If the infection has been of sufficient severity and duration the roentgenograms will show abnormal density of the affected middle ear. The ossicles may or may not be visible and the bony walls of the middle ear, the petrous bone and the mastoid process will show a varying degree of sclerosing osteitis.

A superimposed acute infection in such a mastoid is often impossible to detect roentgenologically.—*D. R. Bernhardt, M.D.*

FISCHGOLD, H., PROT, D., and FISSORE, A. Altérations unilatérales de la clinoide antérieure dans les néoformations du carrefour

sphéno-orbitaire. (Unilateral changes in the anterior clinoid due to neoplasms in the spheno-orbital space.) *Presse méd.*, March 28, 1951, *59*, 400–402.

Tomography in 40 normal subjects established symmetry of the anterior clinoids; there was no significant difference between the two sides. The interclinoid distance measured between 24 and 28 mm. None were less than 23 mm. with one exception and only one measured 30 mm. Asymmetry or a widened space therefore assumes pathological significance. The sections are made 3, 4 and 5 cm. from the frontonasal plane, and usually it is the 5 cm. plane which demonstrates the clinoids best.

A unilateral alteration of an anterior clinoid only rarely is seen with intrasellar tumors such as pituitary adenoma. It has been found in glioma of the chiasm, subfrontal tumor, carotid aneurysm, meningioma of the optic nerve, orbital chondroma and mucocele. The unilateral change has also been seen in 2 cases of meningioma of the lesser wing of the sphenoid. Because of the close relation between the optic nerve and the anterior clinoid, unilateral changes are often associated with atrophy of the optic nerve and homolateral exophthalmus.—*M. L. Sussman, M.D.*

Lorber, John. Studies of the cerebrospinal fluid circulation in tuberculous meningitis in children. II. A review of 100 pneumoencephalograms. *Arch. Dis. Childhood*, Feb., 1951, *26*, 28–44.

The objects of the investigation are stated in the beginning of the article. The objectives are of long term nature and include the following:

1. A better understanding of the circulation of the cerebrospinal fluid.
2. Determination of the points of obstruction within the ventricular system.
3. Determination of the cause of hydrocephalus.
4. Establishment of criteria of prognosis.
5. Correlation of encephalographic pattern with the physical and mental development.
6. Finding of definite criteria for the selection of suitable cases only for treatment.

One hundred pneumoencephalograms were done.

The author was able to draw many conclusions on the basis of the study. Fifty-eight children were studied and, with the possible exception of one case, there were no serious after effects to the encephalograms. The author feels that criteria must soon be established in deciding which cases should be treated and which cases should not be treated. This study goes a long way toward establishing these criteria.

Abnormalities were found in 36 of 48 children. These belonged to three categories: (1) One or more blocks occurred in 30 cases. In all of these there was a block at the tentorial opening or in the basal cisterns, usually present at or soon after the beginning of treatment. (2) In no case of tentorial or basal cisternal block was there subarachnoid air. (3) Hydrocephalus of varying degree was found in 34 cases.

There was a close correlation between the encephalographic appearance and prognosis. Sixteen of 18 children with normal encephalograms were alive after a minimum follow-up period of eleven months, whereas of 26 children with abnormal encephalograms only 8 were alive and they all had more or less serious mental and neurological residual lesions.—*R. E. Kinzer, M.D.*

Meschan, Isadore, and Scruggs, Joe B., Jr. A study of pneumoencephalograms before and after prefrontal lobotomy (Freeman-Watts technic). *Radiology*, Feb., 1951, *56*, 222–228.

A comparison is made of pneumoencephalograms before and after prefrontal lobotomy on 19 unselected psychotic patients. About half of the patients showed no abnormal pneumoencephalographic findings prior to lobotomy. The remaining half exhibited a variable degree of dilatation of the ventricular system and an increase in the amount of air in the subarachnoid space. These changes were interpreted as indicating cortical atrophy or cerebral gliosis.

Pneumoencephalographic studies following prefrontal lobotomy demonstrated a progressive dilatation of all the ventricles, frequently most marked in the anterior portions of the lateral ventricles, and progressive obliteration of the subarachnoid space surrounding the cerebral cortex. Porencephalic cysts developed in 5 cases.

The pathological autopsy findings are described in detail. These include: (a) cystic necrosis of the frontal lobes; (b) atrophy and gliosis throughout the brain; (c) meningeal thickening, scarring, and hemorrhage; (d) generalized enlargement of the ventricles most prominent in the frontal horns; and (d) cystic degeneration of the thalamus and basal ganglia, particularly in the nucleus medialis dorsalis of the thalamus.—*E. E. Seedorf, M.D.*

Epstein, Bernard S. Laminagraphy in the diagnosis of nasopharyngeal tumors. *Radiology*, March, 1951, *56*, 355–362.

The roentgen findings of 10 patients with nasopharyngeal tumors are discussed. Lateral stereoscopic roentgenograms of the skull showed an abnormal nasopharyngeal soft tissue shadow in 3 patients and bone erosion in 2 patients. Stereoscopic roentgenograms of the base of the skull revealed definite bone erosion in 4 patients and questionable bone erosion in 3 patients. Lateral laminagrams showed soft tissue tumefaction in all patients, destruction of the body of the sphenoid in 2 patients, and sclerotic changes involving the sphenoid and basi-occiput in 2 patients.

Lateral laminagraphy is recommended for the

early visualization of soft tissue tumors in the nasopharynx.—*M. B. Goodwin, M.D.*

HOLMBERG, ROBERT E., and GLOVER, DONALD M. Papillary cystadenoma lymphomatosum of the parotid gland. *Surgery*, Feb., 1951, *29*, 240–248.

Papillary cystadenoma lymphomatosum is an uncommon benign tumor of the salivary glands usually affecting the parotid gland. It commonly occurs in middle-aged or elderly males at or below the angle of the mandible and is characterized by lack of pain. The tumor is slow growing and does not recur after complete surgical removal. Irradiation has no significant effect on this type of tumor.

The authors review 151 cases reported previously and add 8 new cases. The theories of origin and pathologic characteristics of this type of tumor are reviewed.—*R. W. Emerick, M.D.*

NECK AND CHEST

SCHINZ, HANS R., and EGGENSCHWYLER, HANS. Organisation und Ergebnisse der Schirmbildaktion im Kanton Zürich (1946–1949). (Organization and results of photofluorography in the Canton of Zürich [1946–1949].) *Schweiz. Ztschr. Tuberk.*, 1950, *7*, 395–403.

A mass chest survey was undertaken in the Kanton of Zürich. A Siemens photofluorograph was used with a film size of 24 mm. Altogether 223,004 examinations were made of which 83.8 per cent remained negative and 16.2 per cent were positive.

A subdivision of the positive examinations is given in Table I.

TABLE I

Positive without importance	26,645 or 11.9%
Positive with relative importance	8,598 or 3.9%
Positive with absolute importance	943 or 0.4%

Table II shows the anatomic distribution.

TABLE II

	Of no importance	Of relative importance	Of absolute importance
Pulmonary	7,403—27.8%	4,237—49.5%	753—80%
Hilar	6,642—25.0%	1,338—15.3%	42—4.5%
Pleural	1,949— 7.3%	809— 9.4%	30—3.0%
Mediastinal	5,110—19.2%	528— 6.1%	49—5.2%
Cardiac	2,434— 9.1%	1,637—19.0%	69—7.3%
Others	3,107—11.6%	59— 0.7%	
Total	26,645—100%	8,598—100%	943—100%

Table III includes a classification of the type of lesion found.

TABLE III

Tuberculosis	2,194 or 22.2%
Non-tuberculous diseases of the lung	2,868 or 30.7%
Cardiac	1,897 or 20.3%
Goiters	538 or 5.7%
Anomalies	369 or 3.9%

Of the 2,194 cases with tuberculosis, 104 were active and open, 419 active but closed, and 1,571 inactive.

Anomalies of the ribs were found in 944 cases, 432 in women and 512 in men.—*H. P. Mueller, M.D.*

LÖNNERBLAD, LARS. The value of a total population roentgen chest survey in the campaign against tuberculosis. *Acta radiol.*, Dec., 1950, *34*, 501–518.

It is the author's opinion that photofluorography of the entire population is not likely to be entirely successful in combatting tuberculosis. He calls attention to some research work which, he feels, has been neglected in the study of this problem.

1. *Incidence of tuberculous infection in the population.* The frequency of positive reactions to tuberculin increases comparatively quickly from the beginning of school age to the age of twenty-five. Thereafter the curve rises more slowly and it does not attain its maximum until the age of forty to forty-five at which time 98 per cent of the population, at least in Sweden, are shown to be positive to tuberculin.

2. *The difficulty of making a prognosis in pulmonary tuberculosis.* The recognition of the subprimary initial focus of tuberculosis is often determined only after a very long period of observation that may require decades. It is often difficult to determine whether the tuberculosis is in the infectious stage. Medlar states that "shadows caused by tuberculous lesions in the upper lung fields should not be interpreted as 'healed' if there are scattered small calcific densities, for the majority of such lesions also contain unorganized necrotic (caseous) areas of tuberculous pneumonia." Even regression of the pulmonary lesion is not always a favorable sign. It may be followed by an even stronger progression.

3. *The results of pulmonary tuberculosis treatment.* The chronicity of this disease introduces the question of the minimum length of observation time necessary to reach valid conclusion; if it is too short, the whole story of the disease process is not encompassed; if it is too long, the effect of treatment may become obscured by complications either of a tuberculous nature or by non-tuberculous disease.

Under present circumstances it is not feasible to isolate effectively all persons with static or intermittently open tuberculosis of the lungs. Moreover, persons infected with pulmonary tuberculosis may unexpectedly develop a rapidly progressive pulmonary process and so have time to infect a considerable number of persons before the diagnosis is established.

Without more effective economic aid to persons with tuberculosis and to susceptible groups of the population and, without widespread BCG inoculation, photofluorographic examinations can hardly produce the desired results.—*Mary Frances Vastine, M.D.*

HAUBRICH, R. Über das Röntgenbild der

Ockerstaublunge. (The roentgen appearance of pneumoconiosis due to ocher dust inhalation.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1950, *73*, 682–688.

Five of 8 cases of pneumoconiosis due to ocher dust are discussed and their chest films presented. Ocher is earth containing iron oxide and hydroxide and a small amount of silicate (8–15 per cent).

The roentgen appearance of this condition is characterized by a fine reticulation and granulation of the lung fields due to very small miliary densities and interstitial fibrosis. Even after exposure for many years the disease does not advance past Stage II. Increased hilar shadows and emphysema of the bases and apices complete the picture, but are not helpful in the differentiation from other pneumoconioses. The second stage with its fine, punctate densities is quite typical and is not seen in the other types of silicosis, except in the iron ore lungs. The peculiarity of ocher lung is the very slow evolution which requires a relatively long time of exposure (1 case had a history of exposure of 52 years) to develop a Stage II lesion. Only 1 case showed plaque formation but there was a history of fifty-two years of exposure.

Ocher dust lung resembles only the iron ore lung, but is differentiated from it by the slow development of the lesions. The other two diseases with iron deposits in the lungs: pure siderosis (iron oxide inhalation in welders) and hemosiderosis (chronic pulmonary congestion in mitral heart disease) are distinguished by the absence of the silicate factor, the deposits of iron in the alveoli, the finding of "heart failure cells" in the sputum, the distribution of the miliary densities through the mid-lung and hilar regions, the absence of interstitial reaction in most cases and the relative reversibility of the lesions after cessation of exposure to iron dust.—*F. M. Reis, M.D.*

Hohn, Mathias, and Vieten, Heinz. Röntgenologische Studien über die Aufteilung des Bronchialbaumes. (Roentgen studies of the branches of the bronchial tree.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1950, *73*, 669–682.

The paper is based on the study of 300 bronchograms. The variations of the segmental bronchi are discussed and their frequency tabulated. The disagreement in the number and nomenclature of the various branches by several authors is demonstrated by several tables. The nomenclature used here is similar to the "Nomina anatomica of 1935" (J. N. A.).—*F. M. Reis, M.D.*

Robertson, Philip W., and Forgan, K. D. Delayed pulmonary complications of bronchography. *Lancet.*, Feb. 17, 1951, *1*, 387.

The authors found that 7.2 per cent of 220 consecutive patients who underwent bronchography (all by cricothyroid puncture) developed one to two weeks after the procedure varying combinations of fever up to 104° F., cough productive of golden-yellow watery sputum, polymorphonuclear leukocytosis, chest pain, and malaise. Chest roentgenograms, when done, showed inflammatory change around the residual iodized oil. Rapid, spontaneous recovery with no specific therapy occurred in all.

Approximately one-third of the 16 patients developed small pleural effusions of yellow, opalescent, sterile fluid containing considerable fibrin and a moderate number of eosinophils. One-fourth of the sick group had urticaria, but there was no evidence of allergic diathesis in any of the patients. Repeated bronchography was not followed by a second consecutive illness.

The authors consider these "reactions" allergic and dismiss the possibilities of associated lung sepsis and activation of latent infection. Coincidental infection was ignored.—*J. J. Gormley, M.D.*

Tourniaire, A., Tartulier, M., and Deyrieux, F. Le syndrome prémonitoire du coeur pulmonaire chronique. (The premonitory syndrome of chronic cor pulmonale.) *Presse méd.*, Feb. 21, 1951, *59*, 227–229.

This is a study based on 18 cases of patients whose chronic pulmonary pneumopathy became aggravated sufficiently to cause them to seek the advice of a cardiologist. The syndrome forms an intermediate stage between chronic pneumopathy and right ventricular insufficiency, and it represents the transition of permanent pulmonary arterial hypertension into cardiac insufficiency.

In the syndrome described by the authors, there were no signs of right ventricular insufficiency. The heart was normal in size. All patients were dyspneic for an average of thirteen months—shortest period, one month, longest, four years. There was never a constrictive sternal pain. Cough, signs of bronchial catarrh and cyanosis of varying degree were present. Blood circulation times were normal. Venous pressure was within physiological limits. Fundoscopic examinations showed 2 cases of retinal cyanosis and 3 of precyanosis out of 12 cases examined. The electrocardiogram did not permit a conclusion as to right ventricular preponderance or the establishment of any criterion for incipient chronic cor pulmonale.

Roentgen studies showed characteristic signs. Cardiac dimensions were normal although occasionally the heart may be small. The pulmonary artery was dilated and pulsatile, but for this finding to have value, three criteria must be fulfilled:

1. Increase of opacity and sharpness of contour of the pulmonary artery, permitting an orthodiagram at the hilus.
2. Dilatation of the vessel to more than 2.5 cm. at its juxtahilar portion, sometimes exaggerating the "bend" formed by the horizontal and vertical portions.

3. Definite expansile pulsations of the pulmonary artery branches, but without attaining the amplitude of the "hilar dance," described by Pezzi.

The authors produce further evidence for their belief by laminagraphic and cardiac catheterization data, which are presented in detail.—*A. K. Wilson, M.D.*

SAMET, PHILIP, and STONE, DANIEL J. Right-sided aortic arch. *Am. Heart J.*, Dec., 1950, *40*, 951–954.

The case of a forty-four year old male with the incidental clinical finding of a right aortic arch is discussed. Roentgenographically there was shown in the posteroanterior view a marked indentation on the right side of the esophagus at the level of the aortic arch. In the oblique and lateral views there was also indentation of the posterior wall of the esophagus, suggesting a retroesophageal transverse arch with left descending aorta. Fluoroscopy and laminagraphy demonstrated, however, that the descending aorta was on the right side. A left aortic diverticulum, a remnant of the embryonic posterior left aortic arch, was postulated to explain the posterior indentation on the esophagus. Angiocardiography confirmed this idea and actually delineated the diverticulum; the left subclavian artery was not visualized directly, but usually this vessel arises from the left aortic diverticulum when such is present.—*Harold Fulton, M.D.*

RUSKIN, HERMAN, and SAMUEL, ERIC. Calcification in the patent ductus arteriosus. *Brit. J. Radiol.*, Dec., 1950, *23*, 710–717.

Anomalous vascular trunks occurring as part of congenital cardiac anomalies are especially prone to atheromatous calcification. Calcium is deposited in very slight amounts in the thickened intima on the aortic side of a closed ductus. In a series of 57 cases of uncomplicated patent ductus in adults, calcification was found in 6, by other authors.

This report describes 4 cases in which there was calcification which was typical in appearance, presenting as an arc of calcification between the pulmonary and aortic arcs with its convexity directed toward the left. Frequently this arc of calcification is a half-circle, and it shows movement synchronous with the aortic pulsation.

There are several types of calcium deposit which may be seen at the left border of the heart requiring differentiation. Vascular calcium deposits might be in the aorta and might be atheromatous, in a coarctation, or in an aneurysm. Other vascular deposits might be in an aneurysm of a ductus, in the pulmonary artery, the coronary arteries, an aneurysm of the sinus of Valsalva, the left atrium, the annulus fibrosus or mitral or aortic valves, pericardium, or an aneurysm of the left ventricle. Extravascular calcification in lymph nodes, cysts, or the left bronchus might cause confusion.

Clinical evaluation of the patient, roentgenologic examination in multiple projections, especially in the left anterior oblique, and body section roentgenography usually permit the differentiation.—*E. F. Lang, M.D.*

JERVELL, OTTO. Pulmonary sclerosis. *Acta med. Scandinav.*, 1950, *138*, 430–436.

Secondary pulmonary sclerosis is said to be found in cases of mitral stenosis, pulmonary emphysema and other chronic affections of the lungs. Primary pulmonary sclerosis exists when other causes of chronic cor pulmonale are not associated. The sclerotic change occurs with long-standing increased arterial pressure.

In so-called cryptogenic cor pulmonale—probably due to pulmonary hypertension—there are cases without sclerosis in the pulmonary vessels. Therefore, in addition to elevated pressure, perhaps another pathogenic factor is needed in order to produce sclerosis in the pulmonary vessels. If this is true, the so-called primary sclerosis ought to be regarded as a type of cryptogenic cor pulmonale with sclerosis. Case histories are quoted to support the view that allergic or infectious lesions of the vessels may possibly play a part. Leopold is quoted as stating that pulmonary arteriosclerosis occurs most frequently in an individual with syphilitic infection, who has in addition to this disease a chronic infection of the lower respiratory tract.

The severe cyanosis seen in some cases of cor pulmonale and pulmonary sclerosis is due to several contributory causes: polycythemia, hypoventilation, pulmonary emphysema and pathologic or functional changes in the small vessels and capillaries of the lung.

The diagnosis of pulmonary sclerosis is difficult because many of the clinical symptoms and signs are not due to the sclerosis but to the increased pressure in the pulmonary circuit. Roentgenographic examination may reveal parenchymal infiltrations which are due to sclerotic arteries. Regarded clinically, the pulmonary sclerosis will hardly do more than accentuate the symptoms. There seems to be no reason for distinguishing between a secondary and a primary form of pulmonary sclerosis.—*Charles Nice, M.D.*

CRADDOCK, WALLIS L. Cysts of the pericardium. *Am. Heart J.*, Oct., 1950, *40*, 619–623.

Cysts of the pericardium are very rare. Their pathogenesis has been ascribed to the following: (1) embryonal ducts, (2) diverticula of the serous pericardial cavity, (3) cystic transformation of a lipoma, (4) fissures in the wall of the serosa in the course of organization of a fibrous exudate, and (5) inflammatory papillary protrusions which have undergone cystic change. The most logical explana-

tion concerns the disconnected lacunae which are the early anlage of the pericardium. These lacunae eventually coalesce to form the pericardial celomic cavity. If one of the lacunae fails to merge, it could persist and give rise to a cyst of the pericardium.

The author's case was a forty-nine year old white male, who exhibited a prominent right hilar shadow on a routine chest roentgenogram. Diagnostic studies were unrewarding. Thoracotomy revealed a soft, cystic, rounded tumor arising from the apex of the pericardium just above the aortic arch. Sections of the cyst showed a loose areolar wall the inner surface of which was lined by villous mesothelium.

Pericardial cysts are benign growths and must be differentiated from echinococcus cysts, embryonal cell rest cysts from the respiratory and alimentary tracts, dermoids and teratomas, and lymphangiomas.—*Harold Fulton, M.D.*

Engle, Mary Allen, and Taussig, Helen B. Valvular pulmonic stenosis with intact ventricular septum and patent foramen ovale; report of illustrative cases and analysis of clinical syndrome. *Circulation*, Oct., 1950, *2*, 481–493.

The authors present a series of 3 cases of valvular pulmonic stenosis with patency of the foramen ovale and intact ventricular septum proved by autopsy. The stenosed pulmonary valve leads to hypertrophy of the right ventricle and eventually of the right auricle. When the pressure in the right auricle exceeds that in the left auricle the venous blood is shunted through the patent foramen ovale. When this volume becomes sufficiently large the level of visible cyanosis is reached. The elevated pressure in the right heart eventually causes venous congestion and enlargement of the liver.

Dyspnea on exertion which may be present from early life, easy fatigability, and later cyanosis are prominent symptoms. Precardiac bulge, systolic murmur and enlargement and pulsation of the liver are usually noted at the physical examination.

The prominent roentgen findings are enlargement of the right ventricle and right auricle with displacement of the left ventricle posteriorly by the enlarged right ventricle so that it may overlap the spine in the left anterior oblique view. The "rocking boat" effect due to the alternate forceful contractions of the right auricle and right ventricle is usually noted at fluoroscopy. It has been noted that when the pulsations in the right auricle remained strong and those of the right ventricle were weak and scarcely visible the prognosis was grave as it was an indication of failure of the ventricular musculature.

The pulmonary conus region was prominent and the pulmonary arteries were normal or enlarged. In spite of these findings, pulsations in the pulmonary arteries were diminished or absent and the lung markings were less prominent due to the decrease in pressure in the pulmonary artery.

Angiocardiograms revealed delayed emptying of the right auricle and right ventricle. Early visualization of the aorta may occur in some cases when the contrast material passes from the right auricle through the foramen ovale into the left auricle.

The differential diagnosis is concerned with the tetralogy of Fallot, Ebstein's anomaly of the tricuspid valve, cor pulmonale and Eisenmenger's complex. If the correct diagnosis is made, patients with this condition will be helped by valvulotomy.—*J. N. Ané, M.D.*

Brebner, H. Dissecting aneurysm of the aorta with renal complications. *Brit. M. J.*, Feb. 24, 1951, *1*, 394–395.

The author describes the case of a male, aged fifty-two, who suffered from a chronic dissecting aneurysm of the aorta. The patient was symptom free until one month before death, but the findings at necropsy indicated a long-standing dissecting aneurysm.

The dissection in this case began at the level of the left common carotid artery and extended throughout the thorax and abdomen, but particularly into the left renal artery and into the main intrarenal branches of this artery. The lumen of the left renal artery was compressed and the left kidney was infarcted. The patient developed rapidly rising hypertension, cardiac failure and uremia. It is suggested that the infarcted kidney was responsible for the rapid development of the hypertension.—*C. L. Hinkel, M.D.*

Kemp, F. H. Factors influencing the mediastinal shadow in young children. *Brit. J. Radiol.*, Dec., 1950, *23*, 703–709.

In young children the width of the mediastinum is not constant but varies with the degree of expansion of the lungs. One of the variable structures is the thymus. It is relatively large in young children but continues to grow until the child is about ten years of age when it undergoes involution. It grows more slowly, however, than the chest, and therefore becomes proportionately smaller as the chest enlarges in the first ten years.

The determination of whether or not the thymus is enlarged is a difficult problem. The most satisfactory indication of the position of the thymus is the notch or triangular lower lateral border of each lobe. The thymus is sometimes seen as a large sail-like shadow on only one side.

In young children the lungs are not completely expanded, and this permits the thymus to broaden, but as growth continues with further expansion of the lungs, the thymus is forced into a vertical position in the mediastinum. It has been suggested that agenesis of lung tissue or atelectasis permits the development of a large sail-like appearance of the thymus. The thymus may thus mask or imitate disease of the lung. A similar situation exists in relation to the identification of cardiac enlargement. When the

thymus extends down over the base of the heart sufficiently, and cannot be identified, one cannot confidently demonstrate nor exclude cardiac abnormality.—*E. F. Lang, M.D.*

WOMACK, NATHAN A., BRINTNALL, E. S., and EHRENHAFT, J. L. Benign obstruction of the lower esophagus. *J.A.M.A.*, Feb. 3, 1951, *145*, 283–288.

The authors report their experience with 23 cases of this condition which they have observed in a period of slightly over two years. Two cases presented weakness of the upper striated muscle with early megaesophagus. There were 15 cases who showed a failure of normal peristalsis in the lower esophageal segment, and frank ulceration was present in 4 of these. In 1 patient there were multiple focal areas of tonic contraction of a functionless nature producing obstruction. Another showed tremendous smooth muscle hypertrophy from just below the aortic arch to the stomach. In 5 patients there was severe inflammation or stricture formation.

The age incidence varied from twelve to seventy-nine years. Males were involved more than twice as often as females. The most common symptom was dysphagia, with more difficulty in swallowing solid than liquid foods. Weight loss varied from 15 to 85 pounds, and vitamin insufficiencies, particularly of the B group, were common. The third most common symptom was regurgitation of retained esophageal contents, and bleeding was occasionally encountered. Seven of the group were found to be mildly emotionally unstable, 6 showed classical psychoneurosis and 10 were considered to be emotionally normal.

In patients in whom there has been only a slight degree of inflammation and in whom the chief difficulty had been a failure of normal peristalsis in the lower esophageal segment, a "U" type of esophagoplasty has been the operation of choice, and the results have been excellent. When there is active inflammation and ulceration of the esophagus it is necessary to do a most extensive gastric resection, removing all the acid-secreting mucosa and then anastomose the esophagus to the distal segment of the stomach. The provision of an additional stoma between the esophagus and the stomach by a lateral anastomosis is usually not effective.

The problem of regurgitation, ulceration and excoriation of the esophageal epithelium following operation still remains a considerable one.—*A. E. Childe, M.D.*

BARRETT, N. R. Chronic peptic ulcer of the oesophagus and "oesophagitis." *Brit. J. Surg.*, Oct., 1950, *38*, 175–182.

In this interesting paper the author discusses the historical derivation, the differential meaning, and his own definition of esophagitis, and peptic ulcer of the esophagus. He makes the point that there has been great confusion concerning the use of the term esophagitis. The causes of inflammation and ulceration of the esophagus include: carcinoma, corrosives, foreign bodies, infections, tuberculosis, syphilis, diverticula, and varicosities. In separate categories are idiopathic esophagitis, or as the author terms it, "reflux esophagitis," and peptic ulcer of the esophagus.

The clinical aspects of reflux esophagitis are discussed. The etiology is thought to be incompetence of the cardiac sphincter with an associated sensitivity of the esophagus. The roentgen findings are well demonstrated. These cases go through phases of marked congestion, ulceration, and then healing stage with extensive fibrosis. This fibrosis has an unusual character in that it appears to ascend. This results in a stricture at the top of the abnormal zone of reaction. The mucosa above this level of stricture is normal.

It is the author's contention, supported by case reviews and study of anatomical specimens as demonstrated by paintings, that chronic peptic ulcer of the esophagus actually consists of ulceration of gastric mucosa. By this it is meant that there is a congenitally short esophagus and the remaining portion of the gullet is a tubular portion of thoracic stomach. The possibility of ulceration of islets of ectopic gastric mucosa has been ruled out to the author's satisfaction, as his review of the literature shows that these areas of ectopic gastric mucosa are always quite small and found in the region of the postcricoid portion of the esophagus. With chronic peptic ulcer of the lower portion of the esophagus fibrotic stenosis is rarely seen. Usually these patients are diagnosed after being seen as emergencies for acute perforation or massive bleeding.—*T. D. Allison, M.D.*

NEGUS, V. E. Pharyngeal diverticula; observations on their evolution and treatment. *Brit. J. Surg.*, Oct., 1950, *38*, 129–146.

The author first sets out to prove that in its early stage a pharyngeal diverticulum is the result, not the cause, of dysphagia.

In the initial phase of swallowing, the pharynx is pulled up over the bolus, which cannot retreat toward the mouth or nose because of the action of the tongue, fauces, and nasopharyngeal sphincter. In the second phase of swallowing, a peristaltic wave executed by the pharyngeal constrictors travels from the nasopharynx to the mouth of the esophagus, forcing the bolus into the esophagus through the momentarily relaxed cricopharyngeal sphincter.

In most animals, the fibers of the constrictor muscles are arranged in a circular manner. In man, the erect posture and recession of the jaws have resulted in descent of the larynx and pharynx so that the lower pharyngeal constrictor muscles are arranged obliquely.

The cricopharyngeal sphincter, by remaining in contraction except when a bolus is passing, prevents esophageal respiration. As a contraction wave passes

down the pharynx, the sphincteric girdle about the larynx constricts, closing the larynx, and the cricopharyngeal sphincter relaxes, opening the esophagus.

The upper anterior esophageal wall, in man, is suspended from the larynx. During swallowing, the ascent of the pharynx and larynx and the fixation of the esophagus below the diaphragm result in a tendency toward separation between the upper circular muscle fibers of the pharynx and its lower oblique fibers. This is more pronounced in the posterior pharyngeal wall because the anterior wall rises with the larynx. When coordination of relaxation of the cricopharyngeal sphincter with the peristalsis of the pharyngeal muscles is not good, the pharynx bulges into the weak area between the circular and oblique muscle fibers of the posterior pharyngeal wall, and the development of a diverticulum has begun.

The muscular incoordination may be brought about in several different ways. The roles of chronic hypopharyngitis, healed inflammatory lesions of the cricopharyngeal fold with consequent contraction and stenosis, excessive contraction of the cricopharyngeal sphincter without obvious pathological cause, and failure of relaxation of the sphincter at the right moment due to deficient sensory nerve stimulation, are discussed. The diverticulum itself produces dysphagia only when, in distention, it is large enough to press on the esophagus.

The author favors treatment of the underlying muscular incoordination and dilatation of the cricopharyngeal sphincter when small diverticula are demonstrated roentgenologically, reserving surgical treatment for pouches which reach the mediastinum. He describes the surgical technique.—*George Cooper, Jr., M.D.*

Benzecry, I. Megaesófago adquirido por "fakirismo." (Mega-esophagus acquired by "fakirism.") *Prensa méd. argent.*, Dec. 15, 1950, *37*, 3053–3055.

Roentgenograms and clinical data are presented in the case of a sword-swallower who was able to "swallow" a billiard ball, 5 cm. in diameter, or four saber blades simultaneously. These feats were made possible by an enormous enlargement of the entire esophagus. The billiard ball lodged in the posterior pharynx while the tip of one saber blade was observed in the esophagus about 1 inch above the dome of the diaphragm. The artist could not be prevailed upon to submit to esophagoscopy.

The tragic end of another "fakir" is mentioned who, in his act, wounded his esophagus and eroded the aorta which resulted in secondary mediastinitis and fatal hemorrhage due to perforation of the aorta.—*E. A. Schmidt, M.D.*

Greene, Raymond. Thyroid acropachy. *Proc. Roy. Soc. Med.*, Feb., 1951, *44*, 159–161.

In April 1950, a seventy-four year old male was seen, complaining of failure of vision and presenting very severe exophthalmos.

In 1932 this patient was examined and found to have exophthalmos, an enlarged heart, an enlarged thyroid and chronic bronchitis. The heart rate was 60 and the rhythm regular. The basal metabolic rate was not measured. His fingers were clubbed. Under treatment with potassium iodide the goiter disappeared. Three years ago the eyes became more prominent and he was unable to close them. The clubbing of the fingers had greatly increased, especially in the last eight months.

Physical examination in April, 1950, showed an enfeebled, slightly obese man who was almost blind. The eyes lay outside the orbits, supported by grossly edematous eyelids. The conjunctivae were edematous and inflamed and there were bilateral cataracts. The pulse rate was 70, but at rest varied between 55 and 70. The blood pressure at rest was 165/95. The heart was enlarged. The thyroid was not palpable and there was no tremor. The skin was cold and dry and there was slight edema of the ankles and sacrum. The lungs were emphysematous. Apart from the exophthalmos, the most striking abnormality was seen in the second phalanges of the third and fourth fingers of the right hand and the third finger of the left hand. The toes, especially the great toes, were also clubbed. A few subcutaneous hemorrhages had occurred on the dorsum of both wrists. There was some pretibial thickening of the skin which, though not characteristic, might be regarded as pretibial myxedema.

Clinical pathological investigations showed the peripheral blood elements to be essentially normal. The blood Wassermann and Kahn tests were negative. Urea was 22 mg. per cent; cholesterol 216 mg. per cent; fasting sugar 84 mg. per cent; 17-ketosteroid excretion 9.2 mg. in twenty-four hours; basal metabolic rate normal; circulation rate (saccharin arm to tongue method) twenty-five seconds; electrocardiogram showed left axis deviation. Roentgen study of the chest revealed a boot-shaped heart with left-sided enlargement, a shadow in the thoracic inlet and a moderate emphysema. A bronchogram was negative. The hands showed subperiosteal new bone formation along the shafts of phalanges and metacarpals. The skull was normal.

The patient greatly improved following administration of mersalyl and thyroid. Ten months later the patient died. The autopsy findings will be reported at a later date.

Extreme clubbing of the terminal phalanges sometimes accompanied by subperiosteal new bone formation associated with thyroid disease has been reported on four previous occasions. These cases are briefly reviewed. The 5 cases are alike in that all occurred in males and all were associated with severe exophthalmos and hypothyroidism. In the 3 cases first described, a severe hypothyroidism supervened on a previous severe hyperthyroidism. There is

some room for doubt as to whether this is so in the case presented, the evidence for hyperthyroidism being incomplete. The basis for the bone changes is unexplained.—*D. R. Bernhardt, M.D.*

JORDAN, ARTHUR, and KELSALL, A. R. Observations on a case of idiopathic hypoparathyroidism. *Arch. Int. Med.*, Feb., 1951, *87*, 242–258.

Chronic parathyroid insufficiency, in persons who have not had an operation on the thyroid gland, is an exceedingly rare condition. Drake, Albright, Bauer and Castleman reported 6 cases and were able to collect from the literature only 8 others which satisfied their diagnostic criteria, the latter being symptoms and signs of chronic tetany, a low serum calcium level, a raised serum inorganic phosphate level, evidence of normal renal function and absence of roentgenological abnormalities in the bones. The last stipulation, however, requires modification, since increased density of bones has been reported by others, and Albright is stated to have re-examined the roentgenograms of his own juvenile patients and found the bones to be of increased density in all of them. Other features which may be present are cataracts, epileptiform attacks and defects of hair, teeth, nails and skin.

The authors present in detail the case report of a patient displaying most of the phenomena which may be associated with idiopathic hypoparathyroidism. Their patient, a boy aged seventeen, was admitted to the hospital with the chief complaints of muscular twitchings since the age of nine, and attacks of dizziness. The latter began at the age of 15½ and consisted of vertigo, stiffness of body and difficulty to relax if he grasped anything. They lasted about half a minute and were usually not associated with loss of consciousness.

On physical examination the patient appeared stunted in growth. He showed frequent involuntary coarse muscular twitchings affecting the face, arms and trunk. Chvosteck's sign was positive, and on one occasion there was a positive Trousseau sign. Initially he did not have cataracts, but developed these later.

The significant laboratory findings included a serum calcium of 6.3 mg., a serum inorganic phosphate value of 9.1 mg., and a serum alkaline phosphatase of 33 King-Armstrong units. The kidney function tests were normal.

Roentgen examination of the skull revealed mottled bilateral calcification in the frontal areas arranged in cylindrical fashion along the line of the lateral ventricles, suggesting that the calcification was in the choroid plexus. Roentgenograms of the extremities showed some delay in ossification and some sclerosis at the distal ends of the diaphyses of the long bones. There was no evidence of vascular calcification. Both the upper and lower jaws contained numerous unerupted teeth.

The patient was treated initially with calcium lactate and large doses of calciferol without effect on the condition, but an increase in the protein intake, together with the continued administration of calcium lactate and calciferol, was followed by disappearance of the tetany and a return to normal of the serum calcium.—*G. J. Culver, M.D.*

TOMKINSON, J. S. Posterior mediastinal goitre; report of three cases. *Brit. J. Surg.*, Jan., 1951, *38*, 271–275.

In these cases, the tumor was seen on the roentgenograms to be on the right side of the mediastinum posteriorly, displacing the trachea anteriorly. In each case, a pedicle connected the cervical and the intrathoracic portion of the goiter. As the lower pole enlarged, it pushed the extension of the posterior lateral portion of the gland into the posterior mediastinum. The tumor passed posterior to the recurrent laryngeal nerve, inferior thyroid artery and carotid sheath. The position of the mass was clearly shown by roentgen examination but the exact nature was not recognized.

Removal by a cervical incision is recommended as the blood supply is from above and the mass can be freed from its surrounding layer of connective tissue and the growth pried out by pressure from below upward.—*R. K. Arbuckle, M.D.*

BOYD, GLADYS. Oesophageal foreign bodies. *Canad. M. A. J.*, Feb., 1951, *64*, 102–107.

Incidence. A study based on 400 cases seen at the Hospital for Sick Children, Toronto, in the past twenty-five years, showed the following most common foreign bodies occurring in the esophagus: (a) coins, 55 per cent, (b) safety pins, 17 per cent, (c) buttons, 11 per cent, (d) others such as thumbtacks, marbles, jacks, whistles, glass, toys, pin, food, etc.

Age. Eighty per cent of the patients were under two years of age.

Symptoms. (A) Acute cases (foreign body recovered within two weeks): vomiting, dysphagia, cough, choking, drooling of excess mucus; 86 per cent of the safety pins, 75 per cent of the coins and 57 per cent of the buttons were removed within twenty-four hours.

(B) Chronic cases (foreign bodies down 1 month to 4 years): cough, wheezing or spasmodic; vomiting solids; dysphagia; noisy breathing with mucus.

Diagnosis. This is based on history, roentgen examination which is associated with appropriate contrast study, if needed, and esophagoscopy.

Treatment. This consists of removal of the foreign body, gastrostomy for feeding if needed, empyema drainage, antibiotics, etc. Only 3 fatal cases were observed in the entire group.—*R. K. Arbuckle, M.D.*

KIDD, HONOR M., and CHRISTOPHERSON, E. Broncholithiasis and broncho-oesophageal

fistula. *Canad. M. A. J.*, Feb., 1951, *64*, 142–146.

A case is reported of a fifty-four year old man who was seized with sudden knife-like pain in the anterior mid chest, lasting about one minute. Within a week he developed productive cough with purulent and blood-tinged sputum and dull ache in the chest which was aggravated by swallowing. Roentgen examination of the chest showed scattered calcification in the posterior mediastinum and right lower lung with increased markings at the right cardiophrenic angle. These findings were not present on a roentgenogram made five years earlier. Esophagus study by barium was normal. A bronchogram showed no evidence of bronchiectasis.

About three months after the first admission, the patient had coughed up several calculi, 2 to 6 mm. in diameter, usually with some blood. He was readmitted after an interval of eighteen months because of fever, chills and headache of one week's duration. Cough had continued and sputum varying from 4 to 12 ounces daily was reported. The roentgen appearance of the chest was unchanged.

Bronchoscopy showed a tumor in the right lower lobe bronchus which on microscopic study was diagnosed as small cell type carcinoma. The aspirated sputum contained tumor cells. After this study several broncholiths up to 12 mm. in size were coughed up.

A pneumonectomy was performed and numerous calcified nodes were found at operation. The right main bronchus was adherent to a diverticulum of the esophagus and a free communication between the esophagus and the right main bronchus existed. Several small calculi were present in the dense fibrous tissue at this site. Later studies refuted the diagnosis of malignancy. The patient was well approximately three years after the operation.

Either of two conditions, then, could have been responsible for this patient's illness: (a) broncholithiasis, (b) broncho-esophageal fistula. The signs and symptoms of broncholithiasis are: (1) bronchial obstruction with cough, fever, chills, and recurring pneumonia; (2) hemoptysis, usually not severe, but often associated with a tearing substernal pain; (3) expectoration of stones.

Broncho-esophageal fistula may be traumatic, infectious, or neoplastic and the signs and symptoms will vary with the causative factors. Dysphagia and episodes of violent coughing are usually present. Pain may be felt over the lesion, substernally between the scapulae or referred to the shoulders or epigastrium. Occasionally severe bleeding either from the lung or esophagus takes place.—*R. K. Arbuckle, M.D.*

Gans, Stephen L., and Potts, Willis J. Anomalous lobe of lung arising from the esophagus. *J. Thoracic Surg.*, March, 1951, *21*, 313–318.

An anomalous lobe of the lung arising from the esophagus is a rare congenital deformity. The authors were able to find no record of such a deformity in the medical literature. This is a report of a case in which an anomalous lobe of lung communicating with the esophagus by means of a bronchus-like tract was found in the chest and successfully treated surgically.

The embryology of the origin of the esophagus and respiratory system from the gut is briefly reviewed. On the basis of the embryological background the explanation of this anomaly and other congenital anomalies in the region is discussed.—*T. C. Stansbury, Jr., M.D.*

Krause, George R., and Lubert, Mortimer. The anatomy of the bronchopulmonary segments: clinical applications. *Radiology*, March, 1951, *56*, 333–354.

"We believe that an accurate understanding of the bronchopulmonary anatomy is essential for the intelligent interpretation of abnormal shadows seen on plain roentgenograms as well as bronchograms." The authors then outline the segments of the lungs, correlating the nomenclature of Brock, Jackson and Huber, and Boyden. Recognition of the two subdivisions of each of the sublobar segments of the upper lobe and the three subdivisions of the superior sublobar segment of the lower lobe is stressed. The appearance of the various sublobar segments is not described, but presented by an excellent series of roentgenograms. The necessity of lateral roentgenograms is stressed.

Recognition of a change in size of a segment is important, a collapse representing a diagnostic and therapeutic emergency; *e.g.*, tumor or bronchiectasis. Also, the prognosis in tuberculosis may be influenced by collapse due to tuberculous bronchitis. Tuberculosis and lung abscess occur more frequently in the subapical segment of the upper lobe and the superior segment of the lower lobe while carcinoma and pneumonia may be found anywhere. Carcinoma arising in the middle lobe bronchus is rare, collapse of this lobe more commonly being due to inflammatory disease and lymph node enlargement.

In regard to pathogenesis, it is now known that pneumonia is entirely a peripheral disease, and, initially, is frequently localized to a segment or parts of several segments. Changes due to bronchial obstruction are localized to the lobar or sublobar segmental distribution. Since the vascular supply closely parallels the bronchial distribution, changes due to infarcts would have a similar distribution. Therefore, if the segments involved do not have a common sublobar orifice, the most probable diagnosis is pneumonia. The incidence of sublobar origin of bronchogenic carcinoma is increasing while that of positive preoperative bronchoscopies is decreasing, owing to the recognition of segmental collapse. The few patients followed with segmental

collapse and negative bronchoscopic findings eventually showed lobar collapse and bronchoscopic findings of carcinoma. Therefore, a bronchogram is indicated immediately when segmental collapse is suspected.

In conclusion, when confronted with a positive chest roentgenogram, a segmental lesion should be ruled out. Once the segmental character of the disease process has been recognized, every effort should be made to establish an accurate etiologic diagnosis.—*M. B. Goodwin, M.D.*

BATES, RICHARD, and DAVEY, WINTHROP N. Tuberculosis in medical and nursing students. *Am. Rev. Tuberc.*, March, 1951, *63*, 332–338.

The writers have compiled the results of observation of nursing and medical students at the University of Michigan. These studies were made with a view toward a further confirmation of the well known fact that nursing and medical students have a greater rate of "tuberculin conversion" and a higher incidence of clinical pulmonary tuberculosis than do students in other fields.

The survey embodies data over a period of ten years' observation of student nurses and a period of three years' observation of medical students. There was no evidence of decreasing or progressive tuberculin sensitivity in the succeeding classes nor was there any indication of increased hazard of infection in any one year.

During the study 20 cases of active pulmonary tuberculosis were discovered and all but 2 of these cases were minimal. All active cases appeared in students who had been negative to 0.005 mg. of PPD on entrance to school.

A standardized method of student testing is recommended so that in the future a comparison of results can be made.—*W. A. Klauber, Jr., M.D.*

HODGSON, CORRIN H., WEED, LYLE A., and CLAGETT, O. THERON. Pulmonary histoplasmosis; summary of data on reported cases and a report on two patients treated by lobectomy. *J.A.M.A.*, March 17, 1951, *145*, 807–810.

Because pulmonary histoplasmosis has a tendency to spread it is not usually thought of as a surgical disease. The authors report 2 cases from the Mayo Clinic in which lobectomy was done.

A review of the literature disclosed 138 authenticated cases with either pathological or bacteriological proof of histoplasmosis; practically every organ in the body has been found involved. This report is concerned chiefly with the 65 having proved pulmonary involvement. Cases of pulmonary calcification without such proof are excluded.

In establishing a diagnosis cultures have a high degree of reliability, and first consideration should be given to securing material for culture. The disease also may be proved by necropsy, microscopic examination of biopsy specimens, and direct microscopic examination of pus, pleural fluid, sputum, peripheral blood and scrapings from lesions. The histoplasmin skin test is of little value to the clinician; it gives positive results on a large portion of the population, and negative results in about half those with proved disease. The complement fixation and precipitin reaction are likewise unreliable.

Pulmonary symptoms are those to be expected: cough, dyspnea, pain in the chest, expectoration, hoarseness, hemoptysis and cyanosis. Pulmonary histoplasmosis has no characteristic roentgenographic appearance, but may resemble almost any lesion seen in the lung.

Recovery from histoplasmosis seems well authenticated, but the disease runs a protracted course, and most patients reported had not been followed adequately.

Case 1. A thirty-six year old male gave history of roentgenographic changes in the right lower lung for eleven years; he was rejected by a draft board six years before on this basis. The first symptom was hemoptysis three months before admission. Roentgenograms revealed a mass in the right lower lung, the size of a grapefruit, thought to be an infected cyst. Right lower lobectomy was performed. The pathologist made a diagnosis of histoplasmosis, which was further confirmed by culture. The patient was alive and well two years later.

Case 2. A thirty-four year old female gave history of cervical adenitis during childhood, including excision and drainage on the left side at the age of six. She developed low grade fever and dry cough, and roentgenograms showed changes in the right upper lobe. During three months at a sanatorium, repeated sputum tests for tuberculosis were negative; a sputum culture for histoplasmosis was positive. Lobectomy was advised and she reported to the Mayo Clinic, where the diagnosis was confirmed. Lobectomy was performed without incident, and six months later she was in good health.—*A. A. Brewer, M.D.*

LUBERT, MORTIMER, and KRAUSE, GEORGE R. Patterns of lobar collapse as observed radiographically. *Radiology*, Feb., 1951, *56*, 165–182.

This is a roentgen study of the various phases of collapse of a lobe of the lung. In order to understand the mechanism of lobar collapse, it must be remembered that the lung is a semi-rigid structure and not deflatable like a balloon. The potential space caused by the decrease in size of a lobe must be filled by diminution in the size of the hemithorax, movement of the mediastinum, elevation of the diaphragm,

expansion of the adjacent lung or a combination of these factors.

In collapse, a lobe does not become a smaller replica of itself, but actually changes in shape so that the usual three-dimensional pyramid becomes finally a flattened triangle with the apex at the hilus. The apex is, of course, fixed at the hilus so that the remainder of the lobe flattens against the pleura and the base of the triangle moves toward the hilus along the curved course of the chest wall. This description of the sequence of events is better understood if one reminds himself that the bronchial framework of a lobe does not permit complete balloon-like deflation and compensatory emphysema of adjacent lung tissue helps occupy the space of the collapsing lobe.

In the case of the collapse of the right upper lobe the interlobar septum moves upward and in the posteroanterior view finally blends with the upper mediastinum. In the lateral view the collapsed lobe appears as a mediastinal wedge with the narrow apex of the triangle in the mediastinum and the base at the uppermost part of the thoracic cage.

As the left upper lobe collapses, the emphysematous lower lobe appears to "push" the diminishing upper lobe anteriorly. In the lateral view this can be seen as an area of increased density occupying the entire anterior portion of the chest. As the collapse progresses to its end stage the posteroanterior view shows a rounded density in the region of the left pulmonary artery, while the lateral view will show a mediastinal wedge similar to the end stage of collapse of the right upper lobe.

The mechanism of collapse of the lower lobes is the same as that occurring in the upper lobes but the expanding normal lung again appears to "push" the collapsing lower lobe posteriorly and medially so that in the posteroanterior view there is a triangular shadow on either the right or left side of the heart with the apex of the triangle in the hilus and the base at the diaphragm. In the lateral view the wedge shadow is again seen with the apex in the hilus and the base of the triangle in the posterior portion of the lower chest.

In the case of middle lobe collapse the posteroanterior view shows a triangular area of increased density with the base at the hilus. The posteroanterior view may be misleading in middle lobe collapse but the lateral view will show that early there is the usual wedge-shaped shadow but rapidly the sides of the triangle approach each other as the emphysematous upper and lower lobes occupy the former space of the middle lobe. The end stage of middle lobe collapse is noted only as a narrow flattened area extending from the hilus to the anterior inferior chest wall.

It is important to remember that co-existing disease of the lung, diaphragm, mediastinum, or chest wall may alter the roentgen appearance of a collapsing lobe and that these roentgen findings will not be substantiated at any time when intrathoracic pressures are abnormal such as during thoracic operations when the chest is opened.—*C. A. Stevenson, M.D.*

Pomeranz, Raphael. Horner's syndrome: roentgen manifestations. *Radiology*, March, 1951, *56*, 363–369.

Horner's syndrome is of importance to the radiologist for its presence directs the roentgen investigation to the cervicothoracic spine, ribs in this area and the upper mediastinum or pulmonary apices.

It consists of unilateral miosis of the pupil of the eye, ptosis of the upper lid, enophthalmos, anhidrosis of the skin of the face, vascular hyperemia of the face and paresthesia or atrophy of the arm. The syndrome is usually produced by a primary or secondary malignant tumor which damages the cervical sympathetic ganglia at the eighth cervical or first two thoracic levels. However, a congenital condition, "status dysraphicus," simulates this syndrome and is due to a defective closure of the primary neural arch with a gliosis similar to syringomyelia. Benign tumors or any benign pressure on the sympathetic chain at the above levels may also produce the syndrome.

Five cases are reported in which the syndrome was due to pulmonary carcinoma with direct extension, undifferentiated carcinoma the source of which was not known, Hodgkin's disease and bone metastases from pulmonary carcinoma.—*C. A. Stevenson, M.D.*

Zollinger, Hans, U. Schädigt die Joduron-Bronchographie das Lungenparenchym? (Does ioduron bronchography harm the lung parenchyma?) *Schweiz. med. Wchnschr.*, March 3, 1951, *81*, 210–216.

In the course of pathological study of lobectomy and pneumonectomy specimens the author noted the frequent occurrence of xanthomatous pneumonia and chronic interstitial pneumonia in association with the primary lesions, *i.e.*, bronchogenic carcinoma, bronchiectasis, and tuberculosis. Of the 25 operative specimens and 1 autopsy specimen, all showed intra-alveolar metachromatically stained masses and occasional granulomas. All of the patients from whom these lungs had been removed had been subjected to bronchography six to sixty-seven days before the operation (average time twenty-six days). The bronchography had been performed with ioduron B, a water-soluble contrast material with carboxyl-methyl-cellulose added to increase viscosity.

A subsequently studied control group of 41 operative and 4 autopsy specimens harboring similar diseases as the above group, but being from patients who had not been subjected to bronchography, showed similar histopathologic findings under the

same staining conditions. Zollinger concluded that the granulomatous lung changes previously reported by others as occurring after ioduron bronchography are actually the result of the primary lung disease. The granulomas he identified as mucus granulomas which form distal to an obstructing lesion of a main bronchus or of a bronchiole, as a result of an epithelial defect in the bronchial wall.

A note following Zollinger's paper by another investigator (Vischer) denies this explanation and asserts the danger of ioduron bronchography. This controversy indicates that the water-soluble iodine-containing contrast materials, and particularly their cellulose viscosity agent, may not be entirely harmless to the patient.—*Harold Fulton, M.D.*

HARTWEG, HELMUT. Über einen unter dem Bild eines Pleuraendothelioms verlaufenden Fall von chronisch-hämmorrhagischer Pleuritis. (Concerning a picture resembling pleural endothelioma following a chronic hemorrhagic pleuritis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1951, *74*, 204–207.

This article records an interesting case of thoracic disease where a chronic hemorrhagic pleuritis following traumatic spontaneous pneumothorax was confused for some time with pleural endothelioma. The nodular appearance of the pleura and the hemorrhagic exudate was also considered roentgenographic evidence of this condition and there had also been apparent microscopic proof. However at eventual necropsy this turned out to be the result of marked thickening of the pleura accompanying a chronic hemorrhagic pleuritis with the formation of multiple fibrin bodies along the pleural surfaces, particularly the parietal side. At the time of death there was no active tuberculosis apparent, although there were old lesions in the apices. The patient apparently died a cardiac death.—*P. C. Swenson, M.D.*

HOCHBERG, LEW A. Endothelioma (mesothelioma) of the pleura; review with report of seven cases, four of which were extirpated surgically. *Am. Rev. Tuberc.*, Feb., 1951, *63*, 150–175.

The author has compiled a review of the subject of pleural endothelioma, including case histories from his own collection.

The extreme variance of opinions by pathologists relative to the existence of primary mesothelioma of the pleura is discussed. The author feels that primary pleural endothelioma is a definite pathologic and clinical entity. The pathologic features as well as the clinical manifestations of this neoplasm are considered. The roentgen diagnosis of this condition is frequently difficult due to the opacity of the solid tumor. It is pointed out that the diagnosis can often be definitely made by following thoracocentesis with the administration of a diagnostic pneumothorax, in which case the silhouette of the tumor nodules on the pleural surface is frequently visualized.

Pathologically the diagnosis is made by biopsy of the tumor itself or by study of the cells in the pleural exudate.

The treatment of pleural endothelioma is surgical, especially when the diagnosis is arrived at early in the course of events. The author presents 7 cases of pleural endothelioma of which 4 were surgically removed.—*W. A. Klauber, Jr., M.D.*

JOHNSON, WALTER R. Spontaneous and complete regression of extensive pulmonary metastases in a case of chorionepithelioma. *Am. J. Obst. & Gynec.*, March, 1951, *61*, 701–704.

It is pointed out that complete spontaneous regression of a proved cancer is extremely rare (or non-existent). Possible exceptions occur in chorionepithelioma.

The author reports the case of a forty-three year old white housewife, para vi, gravida vii, with chief complaint of vaginal bleeding. The only previous abnormality was amenorrhea from September, 1948, until March, 1949, followed by a normal period in April and then spotting daily. Pelvic examination revealed the uterus enlarged to three times the normal size with a firm mass 3 cm. in diameter extending from the right posterolateral wall.

At laparotomy the uterus was found to be enlarged to $2\frac{1}{2}$ to 3 times the normal size, it was firm and congested. A hard, slightly bluish tumor about 3 cm. in diameter extended from the right posterolateral wall. Surgery consisted of total hysterectomy, bilateral salpingo-oophorectomy and incidental appendectomy. Pathological examination revealed a malignant chorionepithelioma infiltrating well into the musculature of the uterine wall.

An Aschheim-Zondek test two days after operation was positive at routine levels. Stereoscopic roentgenograms of the chest revealed widespread metastatic nodes of both lung fields. No irradiation or hormone therapy was given.

Check-up examination five months later showed that the patient was asymptomatic, had gained weight and was carrying on her usual household duties. Pelvic examination remained negative. Roentgenograms of the chest revealed complete disappearance of the metastases and the Aschheim-Zondek test was negative at normal levels. Subsequent examination through next year showed findings essentially as noted above.—*R. D. Moreton, M.D.*

Moyer, John H., and Ackerman, Alfred J. Bronchogenic carcinoma as a differential diagnostic problem in pulmonary disease. I. Carcinoma arising from major bronchi uncomplicated by secondary infection. *Am. Rev. Tuberc.*, Feb., 1951, *63*, 176–193.

This article is the first of a group by the authors in an attempt to classify the pathogenesis of various roentgen and anatomic changes in the lung as related to the location of carcinoma in the bronchial tree.

The preliminary discussions cover the general phases of the subject of bronchogenic carcinoma including: Incidence, operability, and pathogenesis. A classification of the three main groups of bronchogenic carcinoma according to location is also given. These lesions are divided according to:

1. The central type arising from main stem bronchi or their divisions.
2. The central type complicated by infection.
3. The peripheral type or those arising from the minor bronchi and bronchioles.

The bronchogenic carcinomas of the central type have also been broken down into four sub-groups according to the degrees of bronchial occlusion present. The non-occluding central bronchial lesions are usually considered to represent early, minimal disease. However, case reports are given to illustrate that frequently widespread disease is already present with such a minimal appearing bronchial lesion.

The bronchial carcinomata producing partial occlusion of the bronchus involved cause symptoms according to (1) necrosis of the mucosa at the site of occlusion, in which case hemoptysis results, and (2) the effect of bronchostenosis resulting in decreased aeration. In this group the presence of localized "obstructive" emphysema as related to very early ball-valve type lesions is discussed and the authors feel that this type of change is not at all specific for bronchogenic carcinoma. Several case histories are cited to prove their contention.

The central carcinomas producing complete bronchial occlusion are also discussed. It is pointed out that in these cases the diagnosis is usually confirmed at bronchoscopy while attempting to locate the cause of atelectasis.

The hilar type of carcinoma with peribronchial extension is also considered. This type produces unilateral hilar infiltrations which must be distinguished roentgenographically from the lesions of sarcoid, Hodgkin's disease, and certain chronic infections (chronic indurative pneumonia).—*W. A. Klauber, Jr., M.D.*

Moyer, John, H., and Ackerman, Alfred J. Bronchogenic carcinoma as a differential diagnostic problem in pulmonary disease. II. Carcinoma arising from major bronchi complicated by secondary infection. *Am. Rev. Tuberc.*, March, 1951, *63*, 255–274.

The second article deals with carcinomas arising from major bronchi but which have been complicated by secondary infection. The manifestations are changed by the secondary infection to the extent that a new train of diagnostic possibilities must be entertained.

Progressive bronchostenosis is attended by secondary pulmonary infection which may supervene even when obstruction is incomplete. The parenchymal infection results either from repeated hemoptysis or from intrabronchial stasis. The nature of the sputum changes to a purulent, thickened secretion. Further complications, such as pneumonia, bronchiectasis, abscess, or empyema may develop and any one of these may mask the underlying bronchogenic carcinoma. The primary tumor in such a case may be quite small. The authors emphasize that any case showing on the roentgenograms unexplained recurrent "pneumonia-like areas" or "persistent unresolved pneumonia" is considered to deserve exploratory thoracotomy.

The advancement of tumor within the lung modifies the signs of bronchial obstruction, especially those indicative of diminished lung volume. The lung may be expanded by growing tumor and simulate lobar pneumonia on the roentgenograms.

The differentiation between tuberculous involvement of a portion of the lung may be difficult to make from atelectasis due to bronchogenic carcinoma. In these cases laminagraphy may show the markedly increased density commonly localized at the tumor site.

Since the vascular tree of the lung assumes the same distribution as the bronchial tree, thrombo-embolic phenomena may simulate segmental atelectasis due to carcinoma. However, the absence of a decrease in lung volume in the thrombo-embolic cases is a good differential point.

Cavitation is a frequent complication of bronchogenic carcinoma as well as of pulmonary tuberculosis and acute infections of the lung. Neoplastic cavitation usually shows irregular margins of necrosis along the periphery of the excavation. The location of an area of cavitation is of help when it does not conform to the expected location of tuberculosis in the patient's particular age group.

Those cases of bronchogenic carcinoma with supervening secondary infection may simulate many more benign conditions of the pulmonary tree. When the expected course of these conditions does not follow the usual pattern, further investigation such as bronchography, laminagraphy, or bronchoscopy is indicated. The indications for exploratory thoracotomy are also considered.—*W. A. Klauber, Jr., M.D.*

Moyer, John H., and Ackerman, Alfred J. Bronchogenic carcinoma as a differential

diagnostic problem in pulmonary disease. III. Peripheral type: carcinoma arising from the minor bronchi and bronchioles. *Am. Rev. Tuberc.*, April, 1951, *63*, 399–416.

Bronchogenic carcinoma arising from the peripheral bronchial tree produces few early signs and symptoms. By the time of symptomatic onset distant metastases have usually occurred. This results from the absence of obstruction of major bronchi with the subsequent train of events involving large portions of the lobe. In the peripheral type of bronchogenic carcinoma, diagnostic thoracotomy is very often required for a definite diagnosis.

The differential diagnosis of these peripheral lesions is discussed. Laminagraphy and cardioangiography are frequently used to differentiate the lesions of vascular origin from those of neoplastic nature. The presence of calcification within these peripheral solitary nodular lesions is considered to be strongly in favor of an inflammatory etiology. The use of diagnostic pneumothorax is discussed as a means of differentiating the extrapulmonary intrathoracic lesions.

The roentgen manifestations of alveolar cell carcinoma may resemble those of inflammatory infiltrations. The so-called "pulmonary adenomatosis" is considered to be probably a variant of the alveolar cell type of peripheral bronchogenic carcinoma.

The importance of a diagnostic team formed by direct cooperation between clinician, radiologist, bronchoscopist, pathologist, and surgeon is emphasized. By this means rather than through the use of any single method can our diagnostic efforts be elevated to the point of adequate efficiency.—*W. A. Klauber, Jr., M.D.*

PEABODY, HOMER D., JR., and OLSEN, ARTHUR M. Association of bronchogenic carcinoma and diabetes insipidus: report of cases. *Proc. Staff. Meet., Mayo Clin.*, March 14, 1951, *26*, 107–112.

A number of patients with bronchogenic carcinoma who presented the syndrome of diabetes insipidus have been observed by the authors. In 6 cases the evidence strongly favored the assumption that the diabetes insipidus was a manifestation of intracranial metastasis from bronchogenic carcinoma. These cases are presented with short case histories and roentgenograms demonstrating the chest lesions.

A review of the literature on diabetes insipidus during the past thirty years disclosed 6 reported cases of the syndrome secondary to metastatic bronchogenic carcinoma. In all of these cases it was proved by postmortem examination that metastasis from a primary carcinoma of the lung to the posterior portion of the pituitary neural unit had taken place. It is to be emphasized that intracranial metastasis must be suspected in any case of diabetes insipidus, and a careful examination should be made to exclude primary carcinoma of the lung.—*K. K. Latteier, M.D.*

SEALY, W. C. A report of two cases of the anomalous origin of the right subclavian artery from the descending aorta. *J. Thoracic Surg.*, March, 1951, *21*, 319–324.

The anomalous origin of the right subclavian artery from the descending aorta is not uncommon. The vessel arises from the posterior medial surface of the first part of the descending aorta and usually courses posterior to the esophagus, although in some instances it may pass between the trachea and the esophagus or even anterior to the trachea. The diagnosis by roentgenographic examination has been well described by Neuhauser.

This is a report of 2 cases with an aberrant right subclavian artery originating from the descending aorta. In 1 case there was an associated coarctation of the aorta. The second case was unusual in that the aberrant subclavian artery caused displacement of the descending aorta in such a way that right bronchial and lower tracheal obstruction occurred without esophageal obstruction. In the second case there was displacement of the trachea to the left and of the esophagus to the right.—*T. C. Stansbury, Jr., M.D.*

VOGT, ALFRED. Die Isthmusstenose der Aorta. (Stenosis of the isthmus of the aorta.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1951, *74*, 159–173.

Since Crafoord's first operation in coarctation of the aorta in 1944, this condition has assumed major significance. Patients with this condition have been reported living into the late sixties, although the majority die before the age of forty. The cause of death is usually endocarditis or a rupture of a cerebral aneurysm. One does not need angiocardiography to establish the diagnosis of coarctation, although the method is very suitable to establish the site and extent of the stenosis as well as to show the presence of an aneurysm, so that one may decide whether the operation is unfeasible. Many authors claim that sclerosis of the aorta occurs early and that operation should be done as soon as possible.

The diagnosis is aided considerably by roentgen findings of erosion of the ribs. Usually, there is evidence of enlargement of the left ventricle, widening of the large vessels and sometimes an aneurysm usually above but occasionally below the stenosis. The aneurysm can simulate an aortic arch shadow. Some patients may die as a result of rupture of this aneurysm. Body section roentgenography has been of no help to the author in locating the site of the stenosis.

Ten cases of coarctation of the aorta are presented. The diagnosis was established clinically and sub-

stantiated by roentgen findings of erosion of the ribs. Slight erosion signifies a slight degree of stenosis, but the location of the stenosis cannot be foretold by the nature of the rib erosion. Roentgen kymography made it possible to locate the site of the stenosis in a few cases. The aortic arch may be normal in size, but it is in the very location of the arch where an aneurysm could be demonstrated by roentgen kymography.—*Samuel Richman, M.D.*

Helmsworth, James A., McGuire, Johnson, Felson, Benjamin, and Scott, Ralph C. Visualization of the coronary arteries during life. *Circulation*, Feb., 1951, *3*, 282–288.

Results of attempts to visualize the coronary arteries by opaque media injected into the aorta through a polyethylene catheter, are reported for 15 dogs and 10 human patients. The technique of retrograde catheterization of carotid or brachial artery is minutely described.

In 10 of the dogs a branch of one of the coronary arteries had previously been ligated. Death occurred in 5 of the dogs. These were in animals with recent coronary ligation. The procedure of visualization produced electrocardiographic changes in the dogs. The coronary arteries were visualized in 13 of 15 dogs. The point of coronary ligation could be seen about half the time.

In 10 patients the coronary arteries were demonstrated well in 5 cases and fairly well in 3 cases. The authors have reported 1 fatality and believe the method is experimental as yet.—*E. C. Baker, M.D.*

Hülnhagen, Otto. Retrokardialraum und Oesophaguskontrastdarstellung im höheren Lebensalter. (The retrocardiac space and contrast study of the esophagus in advanced age.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1951, *74*, 187–192.

The retrocardiac space is situated between the thoracic vertebrae and posterior surface of the heart and aorta. In mitral heart disease, the enlarged left auricle is usually displaced posteriorly and to the right, more seldom only posteriorly, and rarely posteriorly and to the left. In the young, the diagnosis of enlarged left auricle as shown by the displacement of the esophagus is made easily. However, in people of more advanced age, because the esophagus adheres closely to the aorta, the diagnosis of enlarged left auricle is more difficult. To differentiate between an enlarged left auricle or a tortuous aorta producing a posterior displacement of the esophagus, the following three points are to be considered: (1) In cases of tortuous aorta, the concavity of the displaced esophagus is not occupied by the cardiac shadow, but by lung markings. (2) The concavity of the displaced esophagus is situated somewhat higher above the diaphragm when there is a tortuous aorta. (3) In tortuous aorta, the esophagus deviates posteriorly and to the left which is rare when the left auricle is enlarged.

In kyphosis of the thoracic spine, the radius of the curvature of the esophagus follows that of the spine; if the heart is enlarged, the curvature of the esophagus is more marked than that of the spine.—*Samuel Richman, M.D.*

Vogt, Alfred. Über den kymographischen Nachweis der herznah gelegenen sekretgefüllten Echinococcuscyste. (Kymographic demonstration of a secretion-filled echinococcus cyst situated near the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1951, *74*, 174–183.

Echinococcus disease occurs in two forms, cystic and multilobular. A case is presented in which a large echinococcus cyst containing calcifications was situated behind the right heart. The mass appeared to pulsate strongly. Roentgen kymography showed atypical pulsations of the left border of the heart as well as of the margin of the cyst. These pulsations were interpreted as being transmitted by the descending aorta. The patient was seen again after one year, at which time the cyst had disappeared. Apparently the cyst had been coughed up.—*Samuel Richman, M.D.*

Monahan, David T. Eventration of the diaphragm repaired with tantalum mesh. *New England J. Med.*, March 29, 1951, *244*, 475–477.

This is a case report of a patient sixty-five years of age with eventration of the right diaphragm complicated by a bleeding duodenal ulcer.

At the first operation the thin right diaphragm was plicated and then a sheet of tantalum mesh was placed over the dome of the diaphragm and held in place with tantalum sutures. Following the operation he continued to bleed from the ulcer and on the nineteenth postoperative day the ulcer was resected. Roentgenograms of the chest made fifteen months postoperative showed the repaired diaphragm to be in the normal position. The author concludes that eventration is not always a benign condition.—*J. H. Harris, M.D.*

Morrow, Andrew G. The use of tantalum gauze in the closure of a defect in the chest wall; report of a case. *Surgery*, Feb., 1951, *29*, 288–292.

Attempts to close defects of the thoracic wall using rigid tantalum plates have resulted in infection and persistent drainage. Using tantalum gauze in experiments with dogs, the author found that firm healing occurred.

A case is reported in which tantalum gauze was

used to close a 7 by 10 cm. defect in the anterior chest wall secondary to block removal of recurrent carcinoma of the breast. Recovery was uneventful, and the patient is well six months after operation.—*R. W. Emerick, M.D.*

ABDOMEN

BELLEGIE, NICHOLAS J., and DAHLIN, DAVID C. Adeno-acanthoma of the stomach: report of 2 cases. *Proc. Staff Meet., Mayo Clin.*, Feb. 14, 1951, *26*, 70–75.

Squamous cell epithelioma as an intrinsic gastric lesion is extremely uncommon. Equally rare is the gastric carcinoma that presents an admixture of glandular and squamous cell elements, most commonly termed "adeno-acanthoma." In the world literature, only 9 pure squamous cell carcinomas and 14 adeno-acanthomas have been reported. Eleven of the 14 reported adeno-acanthomas occurred in the pyloric antrum.

Two new cases of adeno-acanthoma are reported, and they represent the only known ones at the Mayo Clinic. The patients were both white males, aged forty-two and forty-nine years. In both instances the lesions were in the pyloric portion of the stomach. Roentgen examination of the stomach revealed an ulcer of the greater curvature in the first patient, but was negative on two occasions in the second patient. The latter, however, showed a small ulcerating lesion near the greater curvature opposite the angle, on multiple gastroscopic examinations.

Sections of the primary lesion from both patients showed a Grade 2, mixed squamous cell carcinoma and adenocarcinoma.

The first patient had involvement of an adjacent lymph node at surgery, and about one year later developed widespread metastases. No evidence of metastases was found in the second patient.—*Gordon J. Culver, M.D.*

VOGT, ALFRED. Die Magenform bei der Relaxatio diaphragmatis; Differentialdiagnose der Relaxatio diaphragmatis. (The configuration of the stomach in relaxation of the diaphragm; differential diagnosis of diaphragmatic relaxation.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Oct., 1950, *73*, 589–602.

In relaxation of the diaphragm the stomach may assume varied configurations from a slight cascade to volvulus and eventually eventration which, the author explains, are stages of development of increasing severity. It is fifteen times more prevalent on the left side according to Fatou. The left dome of the diaphragm is at a higher level than the right, due to thinning of the diaphragm secondary to degenerative changes in the muscles and, in advanced cases, to complete substitution of the muscle structure by connective tissue which most writers consider an acquired condition. The distal end of the esophagus is in its normal position. The stomach fills the space under the elevated dome. Because of the limited elasticity of the lesser curvature and the fixed position of the cardia, the stomach expands on its greater curvature side and rotates upward and to the right. According to the severity of the condition the following forms and positions are recognized: steer horn stomach with slight cascade tendency; slight relaxation, intense relaxation, slight volvulus; intense volvulus, and, in extreme cases, eventration.

Diaphragmatic herniation and diaphragmatic paralysis are to be considered in the differential diagnosis. In the first condition the position of the stomach is above the diaphragm and in the latter, there is a paradoxical movement of the diaphragm. Exceptionally, when all muscle fibers are replaced by connective tissue, a paradoxical movement may also be noted in an eventration. The author performs, in border line cases, in addition to study under the fluoroscope, a kymographic examination of the diaphragm.

The therapeutic measures mentioned are: (1) postural exercises after meals in which the patient lies on the right side halfway on his abdomen with the trunk slightly elevated, and, in severe cases, (2) operation, consisting of a wedge-shaped excision or a transpleural fascial plastic repair of the diaphragm.—*Salomon Silvera, M.D.*

STRELINGER, ALEXANDER. Incomplete obstruction of the small intestine. *Am. J. Digest. Dis.*, Feb., 1951, *18*, 66–70.

Six cases of partial intestinal obstruction are presented. All were operated upon. The etiological factors were: inflammatory lesions in 3; carcinoma of the kidney in 2; and lymphosarcoma in 1 case.

The absence of roentgenologic signs was noted here and in a brief review of the literature.

Emphasis was placed on correlating a clinical history of intermittent distention and colicky pain, deflation with relief by intubation and suction, and laboratory findings of persistent occult blood in the stools.—*A. W. Finestone, M.D.*

ARDRAN, G. M., FRENCH, J. M., and MUCKLOW, E. H. Relationship of the nature of the opaque medium to small intestine radiographic pattern. *Brit. J. Radiol.*, Dec., 1950, *23*, 697–702.

Barium sulfate remains in suspension in water for varying periods of time, depending on the presence and type of a suspending agent. A series of proprietary preparations of barium sulfate was tested with freshly secreted mucus to determine that one which would flocculate least. This one was "raybar," a gelocolloid preparation.

In a group of 7 patients with idiopathic steator-

rhea, a typical flocculated small intestinal pattern was noted in each when the simple suspension of barium sulfate in water was used. Segmentation, clumping, and a "deficiency" pattern were seen. When "raybar" was used in these same patients there was an absence of all these findings. The continuous columns of barium showed the mucosal pattern well, and the only abnormality was some widening of the lumen. The transit time was possibly shorter with the non-flocculating barium suspension. A series of normal patients was observed using both types of meal in each patient, and the pattern showed no essential difference.

It is thus evident that unless the type of meal is known, the small intestinal study cannot be satisfactorily interpreted, and, further, that if some non-flocculating suspension is used a "deficiency" pattern may never be seen. Where maximum clarity of mucosal detail is desired, a non-flocculating suspension should be used.—*E. F. Lang, M.D.*

LIEDBERG, NILS, and BERGLUND, STIG. The distribution of gas in the intestine following laparotomies unaccompanied by complications. *Acta radiol.*, Dec., 1950, *34*, 493–500.

The authors' roentgen studies on postoperative patients show that accumulation of gas in the small intestine is a comparatively rare occurrence if the laparotomy has been brief and uncomplicated such as is the case in the usual appendectomy. In cases of more prolonged intra-abdominal interventions, such as operations on the biliary tract or the stomach, however, there is usually pronounced gaseous distention in the small intestine. As a rule, such distention persists until about the fourth postoperative day. It probably indicates retarded passage and absorption of swallowed air. The fact that there is increased gaseous content in the colon three to four days after operation also fits in with the presumption that the rate of gaseous passage begins to increase at this time. The absence of any fluid levels in the distended small intestine is interpreted as a sign of the benign nature of the gaseous distention.—*Mary Frances Vastine, M.D.*

BROHÉE, GEORGES. Maladie de Crohn et tuberculose intestinale. (Crohn's disease and intestinal tuberculosis.) *Acta gastro-enterol. belg.*, 1950, *13*, 1091–1105.

Crohn's disease is a lymphogranulomatous reaction which is circumscribed, chronic and benign. There is a tendency to progressive hyperplasia of one or more segments of the digestive tract. Intestinal tuberculosis is an infection by the Koch bacillus of one or more segments of the intestine. The bacillus is composed of a large amount of lipoid, notably phospholipid, at the surface. The author reviews the theory of Chess of Chicago that in Crohn's disease the pathologic condition of the wall of the intestine is due to the ingestion of piezoelectric material which produces a proliferative cellular response obliterating the lymphatics and is followed by secondary infection. Among the piezoelectric substances are fine sand, talc, asbestos, quartz and sterols, which include cholesterol and the phospholipid of the Koch bacillus. Evans and Zeit observed that all of these substances produce a common pathologic effect which is additive. Furthermore, the distribution in similar tissues and the complications are identical. To produce the lesions of Crohn's disease, there must be secondary infection. To produce caseation of tuberculosis, there is the toxin of the bacillus.

The author points out that this theory of a common pathogenesis for the two diseases and possibly also for Boeck's sarcoid, the sarcoids of foreign bodies and other granulomas, is most interesting but there are many points which remain obscure. There is no clarification of the rapid amelioration of the edematous hyperplasia early in Crohn's disease following psychiatric therapy or when the mesenteric nerve is blocked by novocain. The allergic manifestations are not explained.

A plea is made for early diagnosis of both diseases while they may be reversible. Nodular and ulcerating intestinal tuberculosis should be sought in all cases of pulmonary tuberculosis even when there are no abdominal manifestations. Segmental enteritis of either etiology should be considered in cases with vague general symptoms of undetermined origin. Careful roentgen examination of the small bowel is the best way to discover even minimal lesions of the intestinal wall, as well as to demonstrate physicopathologic disturbances in the small bowel or cecum ascendens.—*M. L. Sussman, M.D.*

CHRISTOPHE, L., and DE SCOVILLE, A. Récidives de l'entérite chronique aspécifique régionale (Maladie de Crohn). (Recurrence of chronic nonspecific regional enteritis [Crohn's disease].) *Acta gastro-enterol. belg.*, 1950, *13*, 1111–1117.

The authors point out that the original concept that Crohn's disease is limited to the terminal ileum has been widened to include lesions in the cecum, jejunum and even esophagus. Of considerable interest is the method of spread. There is a controversy as to whether it is by contiguity or by continuity through the mesentery.

In this connection, a case of Crohn's disease recurring seventeen years after resection is reported.

In 1922, at the age of thirteen years, the patient, a female, suffered jaundice and persistent right flank pain. At seventeen years, following a pregnancy, there was persistent fever and episodes of diarrhea. Some years later a painful zone developed on the right side corresponding to a D_{10}-D_{12} distribution. She was explored at the age of twenty-four. An indurated segment of distal small bowel was found about 20 cm. long. The thickened segment had a

granular appearance and was wine colored; the disease appeared to end several centimeters from the cecum, and was resected. An ileocecostomy was done. At the time the lesion was thought to be tuberculous but a definite diagnosis was not made.

The patient was lost to follow-up between 1933 and 1943. She then reported that, although there had been gain in weight, bloody diarrhea re-appeared some two months after operation. Bacteriological examination of the stools failed to demonstrate any tubercle bacilli. The lungs were normal.

In 1950, at the age of forty-one, the patient appeared complaining of right paraumbilical pain radiating to the right iliac fossa. Roentgen examination of the intestinal tract showed evidence of partial obstruction of the small bowel with fluid levels in the pelvis. Following a barium meal, active pendular movements were seen in this region. A mass was palpated in the right sacroiliac area where there were no intestinal shadows. An adjacent gas-filled small bowel loop narrowed as it approached this area. The radiologist concluded that the partial obstruction was limited to the small bowel somewhat ahead of the prececal segment. The latter was drawn up by an adhesion and seemed stretched toward the palpable mass.

At exploration, the distal ileal segment leading to the anastomosis was bleached and almost rigidly encased over a length of 15 cm. The lumen was at least twice normal. An uninvolved ileal loop was adherent to it over about 2 cm. At the ileocecal valve, a small terminal ileal segment was found which had been excluded by the previous enterectomy. This was found to be involved as well as its mesentery. A wide hemicolectomy was performed with removal of the small bowel up to 50 cm. proximal to the anastomosis. Microscopic examination confirmed the surgical findings and demonstrated also involvement of the part of the mesentery which drained the previously diseased loop.

The authors feel that two questions must be posed. (1) Even though the enterectomy was performed through macroscopically healthy tissue, were not mucosal and submucosal microscopic lesions present which later spread from the preanastomotic segment either by way of a diseased mesentery or by simple contiguity at the time of the seroserous approximation? (2) Was there left, in situ, at the time of the original operation, and in grossly normal tissue, microscopic involvement at the proximal end of the proximal terminal ileal segment, the appendix and cecum? Involvement of the preanastomotic segment would be by way of the mesentery.—*M. L. Sussman, M.D.*

FROEHLICH, A.-L. Une observation d'entérite de Crohn du jéjunum II; essai pathogénique. (A case of Crohn's enteritis involving the jejunum II; pathogenic consideration.) *Acta gastro-enterol. belg.*, 1950, *13*, 1130–1134.

A case is reported of a thirty-four year old coachmaker who had had abdominal complaints since the age of eighteen. Roentgenographic examination showed only a hypertrophic gastritis with a possible prepyloric ulcer and stasis in the distal loops of the ileum. Because of recurring clinical evidence of obstruction, the patient was explored and three annular stenoses were found 1 meter from the angle of Treitz. In between the stenosed segments, the small bowel was hypertrophied and dilated. There were numerous diseased mesenteric lymph nodes. A segment of 40 cm. of bowel was resected and an end-to-end anastomosis performed. The diseased bowel showed numerous superficial ulcers. A microscopic diagnosis could not be made but the pathologist felt that the process was neither tuberculous nor neoplastic.

The symptoms recurred after three years. Roentgen examination showed a dilated segment of jejunum II with marked haustration, thick plical folds in the cephalic portion and a moulage sign with atony in the caudal portion. Some irregular folds had a pseudopolypoid appearance. The diseased segment was again resected. Later, a gastroenterostomy was necessary because of a prepyloric ulcer.

There is little doubt that the original lesion was one of regional enteritis with cicatrization. There was a recurrence in situ, with subacute features. There was an unusual predominance of eosinophils both in the intestinal lesions and in the mesenteric lymph nodes, which might be interpreted as suggesting an allergic component. The recent reports of a beneficial effect of ACTH might be interpreted similarly.—*M. L. Sussman, M.D.*

CRISMER, ROGER. Maladie de Crohn à localisation jéjunale accompagnée de pancréatite chronique et d'anémie achrestique. (Crohn's disease localized in the jejunum accompanied by chronic pancreatitis and achrestic anemia.) *Acta gastro-enterol. belg.*, 1950, *13*, 1135–1140.

This is another case of chronic enteritis involving the jejunum associated with chronic pancreatitis and almost complete disappearance of pancreatic ferments. Whether there was a direct relation between the two diseases could not be determined but there was no relief following resection, continued diarrhea and steatorrhea leading to cachexia and finally death. There was also an addisonian type of anemia which was resistant to liver extract therapy, and which did not change following operation. Nevertheless, the hyperchromic anemia with anisocytosis and poikilocytosis did become transformed into a normochromic anemia.—*M. L. Sussman, M.D.*

ARMITAGE, GEORGE, and WILSON, MICHAEL. Crohn's disease; survey of the literature and report on 34 cases. *Brit. J. Surg.*, Oct., 1950, *38*, 182–193.

In this well illustrated paper the authors present the clinical and pathological features of 34 cases of Crohn's disease. It is their opinion that this name is to be preferred to regional ileitis or cicatrizing enteritis. The writers credit Crohn with establishing the condition as a clinical entity.

In the pathology the average lesion involves the distal 10 inches of the ileum and extends to the ileocecal valve. It is the authors' opinion that none of the cases of acute terminal ileitis have become chronic ileitis or represent the early stage of this disease. The various pathological stages of the disease are represented by excellent paintings in this article. Hadfield is quoted in that the earliest histopathological change in these cases is endothelial-cell proliferation in the submucous lymph follicles. Giant cells appear at an early stage in these centers and are regarded as specific for Crohn's disease. The etiology remains unknown. Tuberculosis has been ruled out as a definite factor. The relation to sarcoid, virus infection, and psychosomatic factors is discussed.

Treatment is discussed and primary resection is considered safe in uncomplicated cases. In complicated cases ileocolostomy with exclusion of the diseased bowel is a safer procedure. In this group of cases the over-all mortality is 18 per cent. The occurrence rate is 20 per cent.—*T. D. Allison, M.D.*

Bodian, Martin, Carter, C. O., and Ward B. C. H. Hirschsprung's disease. *Lancet*, Feb. 10, 1951, *1*, 302–309.

This article presents the first recorded study of the familial incidence of Hirschsprung's disease. It is based upon 40 consecutive cases which were confirmed histopathologically.

Megacolon without organic obstruction is classified into two groups—Hirschsprung's disease proper and idiopathic megacolon. The second group is much commoner and the enlargement of the colon results from chronic constipation, which is probably acquired some time after birth. The roentgen diagnosis is made by demonstrating dilatation of the colon to the anus. The condition is benign and susceptible to persistent treatment with bowel irrigation.

Hirschsprung's disease proper is a congenital malformation, demonstrable microscopically, affecting a varying length of terminal bowel. The pathology is an agenesis of intramural ganglion cells and a dysplasia of autonomic nerve bundles. It is manifested by lack of coordinated peristalsis in the affected segment, leading secondarily to an active type of megacolon in the bowel proximal to this. The roentgenographic diagnosis is based upon demonstration of an undilated or narrow segment of bowel distal to the megacolon. Resection of the inert distal segment by rectosigmoidectomy is now considered the rational treatment of Hirschsprung's disease. The length of the involved segment varies considerably. A follow-up report on 37 cases treated by rectosigmoidectomy is given.

The evidence supports a genetic origin of the disease. The over-all chances of a male sibling of a known case being affected are about 1 in 5; those of the female sibling being affected are too small to be calculated from this series.

A case is reported showing an agenesis of both nerve fibers and ganglion cells distal to the duodenojejunal junction. This condition has apparently not been reported before. It may be a particularly severe variant of Hirschsprung's disease.—*P. R. Dirkse, M.D.*

Campos Filho, Pedro de Souza. Lipoma submucoso do cólon descendente (A propósito de um caso. Considerações em torno da casuística brasileira). (Submucous lipoma of the descending colon; report of a case; considerations regarding Brazilian statistics.) *Rev. brasil de gastroenterol.*, Sept.–Oct., 1950, *2*, 507–518.

The clinical, roentgenological and pathological findings in a case of a large submucosal lipoma of the descending colon are described in detail. The tumor which had produced chronic invagination was removed surgically, resulting in complete cure. Seven other cases were found during 7,000 autopsies within a twelve year period in the Department of Pathology of the University of São Paulo Medical School.—*E. A. Schmidt, M.D.*

Hertzler, J. H., and Maguire, C. E. Congenital dilatation of the common bile duct; report of two cases in children. *Arch. Surg.*, Feb., 1951, *62*, 275–283.

The authors report 3 cases of congenital cystic dilatation of the common bile duct. A review of the literature, with the addition of these makes 192 authenticated cases. These all presented attacks of nausea and vomiting, and a mass about 10 cm. in diameter in the right upper quadrant of the abdomen.

In 2 cases the cyst was anastomosed to the stomach and duodenum. In the third, it was resected, and the hepatic duct anastomosed to the duodenum.—*F. H. Squire, M.D.*

Carter, R. Franklin, and Gillette, Lee. Benign stricture of the intrahepatic bile ducts. *J.A.M.A.*, Feb. 10, 1951, *145*, 375–379.

Although stricture of the common and cystic bile ducts has been recognized as a cause of jaundice following previous cholangitis or operative interference with the biliary system, the existence of similar strictures in the intrahepatic bile ducts is not generally recognized. When surgery for plastic repair of obstructive jaundice is performed, the authors feel that dissection of the hepatic ducts should be done to a

point some distance within the liver. Preliminary to this dissection they have found it useful to obtain cholangiograms upon the operating table in order to determine, if possible, the site of the intrahepatic stricture. Illustrations are used demonstrating strictures of the left and right hepatic ducts in these operative cholangiograms. The article discusses the method of plastic repair of these strictures around a T-tube and the possibility of anastomosis between various hepatic ducts and the intestinal tract.

The chief contribution from the roentgenological standpoint is the extension of usefulness of the cholangiogram made on the operating table as a guide in the determination of surgical procedures to be employed.—*R. P. Barden, M.D.*

SANTY, PAUL, and MARION, PIERRE. Portographies per-opératoires pour syndrome de Banti. (Portography during operation for Banti's syndrome.) *Presse méd.*, Feb. 21, 1951, *59*, 221–223.

Based on an experience with 25 cases, the authors present a means of differentiation, during operation, between intrahepatic and extrahepatic obstruction in so-called Banti's syndrome. They found 5 cases of intrahepatic block (which, they claim, is the true Banti syndrome) and 10 cases of extrahepatic block, either stenotic or thrombotic in nature.

After ligation of the splenic artery, a fine catheter is introduced into the splenic vein and the pressure of the portal system measured manometrically. Forty cubic centimeters of 70 per cent or 50 per cent diodrast is injected rapidly through the catheter and films are exposed immediately and one to two minutes later. The usual preliminary precautions are taken to ascertain sensitivity. The authors have had no deaths and only one disquieting reaction.

Extrahepatic block may be of two types: (a) thrombotic—either chronic pylephlebitis with recanalization, or thrombosis of portal vein with partial invasion of the splenic vein, and (b) stenotic, which may be due to congenital anomaly or to pressure from without by a mass, such as subhepatic abscess. They feel that the so-called Banti syndrome of children is, in reality, most often a portal vein stenosis and should not be classed as Banti's syndrome.

In intrahepatic block there is dilatation of the portal system, especially of the splenic and portal veins, more rarely of the superior mesenteric vein, and still more rarely of the inferior mesenteric vein. Both branches of the portal vein and their terminal collaterals are dilated, but the intrahepatic venous circulation is never completely blocked and the liver appears impregnated with diodrast.

From the standpoint of surgical indications, portography may have definite advantages in three circumstances:

(1) To detect a thrombosis of the origin of the splenic vein, thus obviating a splenorenal anastomosis after splenectomy.

(2) To ascertain the patency of the portal trunk before undertaking a direct portal-caval anastomosis, particularly in a patient who has already had splenectomy for Banti's syndrome.

(3) To demonstrate the splenorenal cause, after splenectomy, in case of extrahepatic portal obstacle with only slight portal hypertension; in this instance the angiographic visualization of the extrahepatic portal obstruction is superior to the manometric procedure.

Routine manometric and angiographic examinations of the portal circulation will permit one to systematically "dismember" Banti's syndrome, separating from it the cases of extrahepatic portal obstruction, and preserving under its true name, cirrhotic splenomegaly, of which the etiology is still a mystery.

The article is illustrated with 9 excellent figures.—*A. K. Wilson, M.D.*

EVERETT, E. FRANK, and FINK, DANIEL L. Mesenteric lipoma: report of a case with distinctive roentgenographic features. *Radiology*, March, 1951, *56*, 370–375.

Both solid and cystic mesenteric tumors are characterized by a painless, growing, abdominal mass which is mobile transversely and not intrinsically in the gastrointestinal or the genitourinary systems. Approximately 30 per cent of the solid tumors are lipomas.

A lipoma may be differentiated from other mesenteric tumors by its lobulated appearance and its relative radiolucency when visualized on a posteroanterior roentgenogram. Cystic and other solid tumors, except for some dermoid cysts, will show an area of increased density. Two cases, one a mesenteric lipoma and the other a mesenteric cyst are reported.—*M. B. Goodwin, M.D.*

WEINBERG, FREDERICK S. Are achlorhydria, achylia gastrica and pernicious anemia precancerous conditions? *Am. J. Digest. Dis.*, Feb., 1951, *18*, 45–52.

One of the major problems in medicine today is that of making a sufficiently early diagnosis of carcinoma of the stomach. Systematic roentgen examinations of the population have been made in an effort to recognize gastric carcinoma in its early or silent phase.

From the reports of various workers it was found that the incidence of finding carcinoma in asymptomatic persons is very low, and it was proposed to examine a selected group of those persons who might be inclined to a higher incidence of carcinoma of the stomach.

Within the past fifteen years the number of pa-

tients with pernicious anemia associated with gastric carcinoma has risen from 0.16 to 1.7 per cent. The author discusses the relation of achlorhydria and achylia gastrica to pernicious anemia and to gastric carcinoma. Achlorhydria, absence of free hydrochloric acid, is a symptom found in many diseases. Achylia gastrica, no gastric secretion at all, is a circumscribed entity in itself. Chronic gastritis is also discussed as a possible precursor of pernicious anemia or gastric carcinoma. The authors, however, contend that chronic gastritis is not a common link between carcinoma of the stomach and pernicious anemia.

Two different theories are advanced as to the reason for the increase in gastric carcinoma in patients with pernicious anemia: (1) Due to liver therapy the pernicious anemia patient's life is prolonged into the carcinoma age. (2) There may be a carcinogenic agent in the liver preparations used. The authors feel that the age increase is not sufficient to be of importance. Further controlled studies are needed to determine if the liver actually contains a carcinogenic agent.—*J. M. Kohl, M.D.*

Haley, Timothy, and Sennott, Waldron M. The diagnostic accuracy of the roentgen examination in diseases of the upper gastrointestinal tract. *Radiology*, March, 1951, *56*, 416–419.

The accuracy of the roentgenologic examination of the upper gastrointestinal tract depends greatly on the experience of the examiner and has been estimated to be from 50 to 80 per cent correct.

In this paper the roentgen and surgical findings are compared in 202 cases. There were 84 cases of duodenal ulcer in which the roentgen diagnosis was correct in 74. The 10 errors were roentgen reports of ulcer on the gastric side of the pyloric ring (6 reports), cancer of the pylorus (2), ulcer of the stomach (1) and negative (1). Thus, the roentgen diagnosis in cases of duodenal ulcer was 88 per cent correct.

A pathologic diagnosis of gastric ulcer was made in 54 of the 202 cases. The roentgen diagnosis was correct in 49 instances, or 90 per cent. The roentgen errors were 4 reports of duodenal ulcer and 1 negative.

Thirty-three gastric neoplasms were found and the accuracy of roentgen diagnosis was 90 per cent. There were 3 errors: extragastric lesion, duodenal ulcer, gastric ulcer. Walters, in a report of 2,469 cases of gastric carcinoma, found a 75 per cent roentgen accuracy.

A group of 7 patients in whom the roentgen report directed attention to some pyloric pathologic change had no abnormality as demonstrated by surgical exploration. The authors quote Judd as saying that the clinicians and radiologists in his clinic are not considered in error unless the stomach or duodenum are opened and visibly inspected at the time of surgery.—*C. A. Stevenson, M.D.*

Jacobson, Harold G., and Camp, Walter H. Situs inversus of the abdominal viscera with volvulus of the large bowel; report of a case. *Radiology*, March, 1951, *56*, 423–426.

In situs inversus many other developmental anomalies occur. These may be in the form of abnormalities of rotation of the gut and inadequate fixation of portions of the intestine. Volvulus most commonly is encountered in the sigmoid flexure. It is rarely observed in the transverse colon due to the wide attachment of the mesocolon. However, if there is an anomaly of the transverse mesocolon, volvulus can occur.

The case history of a twenty-nine year old colored male is presented. The patient entered the hospital with symptoms and physical findings of intestinal obstruction. The chest roentgenogram was normal. Abdominal roentgenograms showed marked distention of the bowel and fluid levels in the erect position. An emergency barium enema study revealed a situs inversus of the colon with an interruption of the barium flow at the mid-transverse colon. Here, there was noted a cane-like narrowing which suggested a volvulus. At operation there was found a complete situs inversus of the gastrointestinal viscera. The cecum, ascending, and proximal half of the transverse colon were freely mobile. A fine congenital band across the transverse colon had caused the mobile ascending and proximal half of the transverse colon to angulate to the right, producing volvulus and intestinal obstruction.

The congenital band constricting the transverse colon was cut and the cecum was tacked into the lower left quadrant. The patient made an uneventful recovery.—*E. M. Cooper, M.D.*

Ruzicka, Francis F., Jr., and Rigler, Leo G. Inflation of the stomach with double contrast; roentgen study. *J.A.M.A.*, March 10, 1951, *145*, 696–702.

Various previous methods of examining the stomach by double contrast or insufflation are discussed and the literature is reviewed. The authors employ inflation with double contrast to differentiate between atypical or unusual groupings of rugal folds and malignancy, and between diffusely enlarged folds and lymphoblastomas.

As a supplement to the routine examination a stomach tube is passed when about 50 per cent gastric emptying has occurred. If done on another day, a single swallow of thin barium is given after passing the tube, and the mucosa is coated by manipulation. Then, with the patient in the supine position, air is injected to definite fullness without pain (500 to 1,500 cc.). Spot films are quickly made

before loss of air occurs by escape into the duodenum or eructation. For demonstration of various portions of the stomach appropriate positioning is utilized. Examples of situations in which the method is helpful are illustrated.—*P. O. Rague, M.D.*

ROVIRALTA, EMILIO. Association de sténose hypertrophique du pylore et d'ectopie gastrique partielle (syndrome phréno-pylorique). (Hypertrophic pyloric stenosis associated with partial gastric ectopia (phrenopyloric syndrome). *Arch. d. mal. de l'app. digestif.*, Nov., 1950, *39*, 1103–1114.

Three cases of hypertrophic pyloric stenosis associated with partial gastric ectopia or diaphragmatic hernia are reported by the author. The first case was observed as the result of the failure of a pyloroplasty to improve a case of hypertrophic pyloric stenosis. It is assumed that the incidence of that pathological association is relatively higher than so far suspected.

The author believes that such pathological association gives rise to what he calls the "phrenopyloric syndrome." He believes that early vomiting during the baby's feeding in pyloric stenosis is due to the coexistence of partial diaphragmatic hernia. In pyloric stenosis alone, the baby rarely vomits before completing his feeding, whereas in gastric ectopia there is vomiting during the course of the feeding. The presence of blood streaks or dark blood in the vomitus is strongly suggestive of the existence of partial gastric ectopia. Adequate roentgen examination will often establish the exact diagnosis and thus determine the proper treatment which is outlined in this paper.—*Jean Bouchard, M.D.*

CARTER, C. O., and SAVAGE, T. R. Pyloric stenosis in four first cousins. *Arch. Dis. Childhood*, Feb., 1951, *26*, 50–51.

This article is based on clinical experience encountered with a family in which 5 of 11 brothers and sisters had children and 4 of them had a child with pyloric stenosis. This family history is reported to show that genetic factors play some part in the etiology of pyloric stenosis.

The authors note that it would be an extraordinary coincidence for these 4 children to be affected, unless there were a genetic factor.—*R. E. Kinzer, M.D.*

POWELL, B. W., and CARTER, C. O. Pyloric stenosis in twins. *Arch. Dis. Childhood*, Feb., 1951, *26*, 45–49.

The authors' paper was apparently prompted by their experience with four pairs of twins affected by pyloric stenosis. Three were monozygous with one of each pair being affected. One was dizygous with both affected. These 4 additional cases of twins are added to a previous series of 1,000 cases reported in 1938 by Sheldon.

Sheldon concluded that the evidence indicated that when pyloric stenosis affects monozygous twins, both infants show the condition, but when the twins are dizygous, only one of the pair is usually affected. The 4 cases reported by the author tend to refute the evidence presented by Sheldon's report.

The author discusses the difficulties in diagnosis of pyloric stenosis, as well as the difficulties in determining the type of twinning.—*R. E. Kinzer, M.D.*

MAGGI, A. L. C., MEEROFF, M., and KUPERMAN, A. Tumores benignos de estómago. (Benign tumors of the stomach.) *Semana méd.*, March 22, 1951, *98*, 403–417.

The authors describe 5 cases of benign tumors of the stomach from an extensive gastroenterological practice, which included 2,500 gastroscopies. Two patients had schwannomas and 1 a leiomyoma. These were operated upon because of hemorrhage and anemia. No operation was done on the remaining 2 cases, 1 of which was an antral polyp diagnosed gastroscopically. The fifth case was that of a small sessile, very vascular tumor at the junction of the upper and middle thirds of the body on the greater curvature.

Four of these tumors were seen as filling defects on roentgenologic study. The gastroscopic examination was considered as being of great value in ascertaining the shape, location and character of the lesion. Of special importance is the ability to distinguish between true polyps and pseudopolyposis.—*M. M. Friedman, M.D.*

ALBOT, GUY; OLIVIER, CLAUDE; LIBAUDE, HENRY; and VALLIN, JACQUES. Retentissement duodéno-cholédoco-pancréatique des ulcères duodénaux et ictères des gastrectomisés. (Relationship between postgastrectomy jaundice and the influence of duodenal ulcer upon the duodeno-choledocho-pancreatic function.) *Arch. d. mal. de l'app. digestif.*, Nov., 1950, *39*, 1086–1102.

The close relationship between the pathology of the duodenum and that of the biliary tract is well established. Yet the way in which duodenal ulcer causes biliary trouble is not fully understood.

Spasticity of Oddi's sphincter is not unusual in duodenal ulcer or following gastrectomy for duodenal ulcer. Cholangiography with manometric determination seems to be the best way to detect such spasticity during the operation and, preferably, postoperatively.

In the majority of the cases in which there are signs of spasticity of Oddi's sphincter, this seems to be a manifestation of both organic and functional disturbances related to inflammatory changes in the

duodeno-choledocho-pancreatic area. The clinical picture varies considerably from mild infrahepatic pain to intermittent or chronic jaundice.

The authors believe that coexistent Oddi's sphincter and biliary ducts syndromes are related to retrograde lymphatic inflammation extending from the duodenum to the neck of the gallbladder, associated with spasm of the cystic duct and Oddi's sphincter.—*Jean Bouchard, M.D.*

Schwartz, Nathaniel H., Swingle, Roy C., and Raymond, Edward A. Malignant tumors of the duodenum; report of two cases. *Arch. Int. Med.*, March, 1951, *87*, 410–417.

To date 483 cases of malignancy of the duodenum have been recorded. The authors add 2 more cases, one a carcinoma, the other a leiomyosarcoma. Sarcomas are about one-tenth of the frequency of carcinomas.

Symptoms depend on the duration and extent of the disease. They may be early, vague and referable to the stomach, gallbladder or pancreas. With encroachment on the biliary system there will be jaundice. Hemorrhage is frequent, and obstruction will occur as the growth progresses into the lumen.

Roentgen examination is the most important adjunct in diagnosis. There may be a loss of mucosal pattern, thickening and fixation of the wall. As the lesions progress and ulcerate, filling defects and craters will be observed.

Metastases occur late and surgical intervention may offer a cure.—*Joseph Levitin, M.D.*

Lurà, A. Examen radiologique de l'intestin grêle au moyen de la sonde duodénale, en particulier pour le diagnostic des tumeurs. (Roentgen examination of the small intestine by means of a duodenal tube, in particular for the diagnosis of tumors.) *Radiol. clin.*, March, 1951, *20*, 97–111.

The roentgenologic examination of the small intestine formed during the past few years the object of numerous contributions, most of which were concerned with the technique of the examination.

The author divides the various techniques employed into two large categories: (a) those which aim to accelerate the passage of the barium through the small intestine by means of medicinal preparations or by the administration of a cold opaque mixture, and (b) those which eliminate the interference of the pyloric passage by the introduction of tubes directly into the small intestine.

He recently performed several investigations by following the Weintraub method which consists in the partaking of a greatly cooled opaque meal with a large quantity of fluids. He found that the passage of the opaque meal was considerably accelerated, the head of the opaque column reaching the cecum within about an hour. This procedure, however, has several disadvantages: (a) it is not applicable to a large number of patients whose chief symptom is vomiting, (b) it alters the function of the small intestine to an extent which is not less than that produced by the introduction of tubes, (c) it does not permit the administration of the barium directly to the desired site and in the desired quantity, a fact which is easily accomplished by means of the tubes, (d) it does not permit the withdrawal of the barium as is the case with the tubes, (e) it does not permit the insufflation of air for double contrast study, which again is easily done by making use of the tubes, and, finally (f) it consumes a comparatively longer time than the rapid examinations performed with the aid of the tubes.

The author then discusses the value of the various tubes employed for the study of the small intestine. He divides them into (1) long tubes of the Miller-Abbott type which are used chiefly in the Anglo-Saxon countries and (2) the short tubes of the Einhorn type which are favored by the author himself. Of these latter, most useful are the short duodenal tubes patterned on the Einhorn tube and modified in various ways by Pesquera, Wissemberg, Schatski, Ghelew and Mengis.

The author practiced intubation with a short duodenal tube more than 300 times during the past four years and he has never observed an untoward effect. The introduction of the tube is easy and a fluoroscopic guide through the pylorus is necessary in less than 10 per cent of the cases. Even this percentage can be reduced by the administration of suitable antispasmodics.

This method permits a roentgenologic examination of the entire small intestine in a quarter of an hour. It represents the sole method (1) when vomiting constitutes the chief symptom, and (2) in a study of lesions of the duodenum and the upper portion of the jejunum. In certain instances it is advisable to supplement this examination by a barium enema which is done the following day after intravenous injection of 1 mg. atropine and 1 gm. calcium gluconate to relax the ileocecal sphincter.

The most important advantages of the examination with the aid of short duodenal tubes are (a) the independence of the pyloric passage, (b) the possibility of introduction of the opaque medium directly to the site of the lesion, (c) the possibility of withdrawal of the opaque medium, and (d) the possibility of introduction of air for double contrast study.

The article is illustrated with numerous roentgenograms showing the salient points of the technique and the advantages of the method in typical cases.—*T. Leucutia, M.D.*

Norris, William J., and Brayton, Donald. Acute abdominal conditions of infancy and childhood; summary of present concepts of

early diagnosis. *J.A.M.A.*, March 31, 1951, *145*, 945–950.

Early diagnosis of acute abdominal conditions in infancy has become increasingly important and possible because of a better understanding of physiology, body chemistry and use of antibiotics. The history obtained from the patient's mother should be given sufficient time for accuracy. Physical examination may be repeated to reduce the factors of childhood fear.

Laboratory aids and roentgenographic studies are discussed. Only the necessary laboratory work should be requested and this should be accomplished without delay. The authors state that barium sulfate for roentgenography in diagnosis of acute abdominal conditions is rarely necessary or may be actually detrimental. Plain roentgenograms, however, are frequently very helpful. They believe that the exact pathological diagnosis is finally reached at the time of operation.—*F. B. Markunas, M.D.*

FRIMANN-DAHL, J. Radiological experiences in true strangulating obstructions. *Acta radiol.*, Feb.–March, 1951, *35*, 85–100.

This work is based on a study of 410 cases of small intestinal obstruction, 60 of which were true strangulations. The strangulating obstructions were divided into two groups, those giving clear roentgen evidence of an ileus and those giving minimal roentgen findings. The author notes that in approximately 5 out of 5 small intestinal obstructions the surgeon can expect to find a severely damaged intestine. He feels that the use of the Miller-Abbott tube in acute obstructions is very limited, but advocates the use of oral barium in these cases.

The amount of gas and the number of fluid levels may indicate the duration and site of the obstruction but these factors are no reliable index as to the severity of the ileus. On the contrary, but little gas accumulates in the most severe cases and the fluid levels are few in number and short.

The following interesting points are brought out in this article:

1. There is a tendency to delayed propulsion with retention of barium in the stomach and upper jejunum in complete small intestinal obstructions. If the barium does proceed as far as the stenosis and is stopped by the obstruction, the prestenotic coils may be displaced by the tumor-like incarcerated loop in strangulating obstructions.

2. Usually there is no gas in the incarcerated loops which are often larger than normal due to an increased accumulation of fluid in them. It is important to look for a tumor-like density formed by the incarcerated loops. They are most often found in the lower part of the abdomen and the lesser pelvis.

3. Only occasionally is gas present in the incarcerated loops of intestine.

4. It is important to repeat the examination when obstruction is suspected but in which the roentgen findings are equivocal. Thus, in a case of the writer's the first films showed very little small intestinal gas while a film taken eight hours later showed small but definite hoop-shaped loops and short fluid levels. At operation 50 cm. of infarcted loops of ileum were found.

5. The more severe the strangulation, the fewer are the gas-filled intestinal loops, a fact which makes the diagnosis most difficult in the most dangerously ill patients.

6. Gas in the large bowel does not rule out the presence of a strangulated small bowel.—*Mary Frances Vastine, M.D.*

FRIMANN-DAHL, J. Experimental ileus in rabbits. *Acta radiol.*, Feb.-March, 1951, *35*, 101–114.

Experiments on 40 rabbits were made in a study of the small intestine in simple and strangulating obstructions. The findings were controlled by means of repeated roentgen examinations followed by study of the autopsy specimen.

The following conclusions were reached:

1. The greatest accumulation of gas was found in simple occlusions proximal to the obstruction. The distal portion of the intestine in these cases was nearly devoid of gas and fluid.

2. In strangulating obstructions, moderate amounts of gas were found above the stenosis. Fluid was also present in abundance proximal to the obstructed site.

3. In about half the cases, a small gas bubble was detected in the strangulated loop. This was probably due to putrefaction or bacterial decomposition. The strangulated loop was always increased in size due to transudation of semifluid hemorrhagic content.

4. The rule of a local meteorism in a strangulated loop seems not to be valid in so far as the small bowel is concerned.—*Mary Frances Vastine, M.D.*

KAHLE, H. REICHARD. Intussusception in children under two years of age; an analysis of fifty-four cases from Charity Hospital of Louisiana at New Orleans. *Surgery*, Feb., 1951, *29*, 182–195.

The author presents a discussion of 54 cases of intussusception which occurred during a ten year period. The patients were children less than two years of age who were admitted to Charity Hospital in New Orleans. A previous series of 88 similar cases had been reported which included all cases up to 1938. The over-all mortality rate in the present series was 25.9 per cent as compared with 63.6 per cent in the earlier series. The author considers

the present mortality rate excessive for this lesion, and the present series is reported to analyze these cases from the standpoint of diagnosis, therapy and factors influencing mortality.

The race of the patient as well as seasonal factors were not thought to influence the development of the lesion. The greater frequency of intussusception among males which is noted in all other recorded series was evident in this series as well. In 50 of the 54 cases the condition occurred during the first year of the patient's life and in the majority of cases it occurred when the patient was three to eight months of age. A change from milk to a more solid diet, which usually occurs at about the age when the incidence of intussusception is greatest, has been suggested as a possible explanation for the age distribution noted in this as well as in other series. An adequate explanation is not known, however. Definite etiologic factors were not demonstrated by this series. In 1 case Meckel's diverticulum was thought to have initiated the process. Ladd and Gross are stated to have considered allergy as a possible explanation but have added no evidence to substantiate this theory. In the present series 1 child had a history of gastroenteritis several months before the onset of intussusception. At necropsy, twelve hours after operation, evidence of acute and chronic colitis with ulceration was found, and it was suggested that an old inflammatory process may have served as a starting point for the lesion.

Three siblings of Negro parents had intussusception of the ileocolic variety within four years. In most cases the usual clinical pattern of intussusception was noted, including pain, a history of vomiting and the passage of bloody stools. In 32 cases a definite mass had been palpated in the abdomen. One case is described in detail because of the atypical symptoms which were present; namely, loss of weight, recurrent upper respiratory infections and evidence of dehydration and drowsiness. A definite mass was palpated in the right upper quadrant. At operation ileocolic intussusception was found. Subsequently the patient died and necropsy revealed bilateral pulmonary tuberculosis and tuberculosis involving the liver, spleen and kidneys, as well as tuberculous ileocolitis and mesenteric lymphadenitis.

Roentgen examination is said to be helpful in some cases, but it is not always necessary because the diagnosis in most cases can be made clinically.

In 5 cases intussusception reduced itself spontaneously. In 4 cases operation was undertaken. Reduction was incomplete in 1 case and further treatment was required. In 5 cases intussusception was reduced during roentgen examination with a barium enema. This method may be useful in some cases, but it is difficult to evaluate the status of a bowel that cannot be inspected and palpated. In certain previously reported cases the results of reduction by this method were better than those reported for surgical measures. The results of these two methods, however, are not comparable because of other important factors such as the length of time between the onset of the lesion and the beginning of treatment. This is usually shorter in the case of treatment by means of barium enemas. Reduction by this procedure must be done with every possible precaution and all manipulations must be very gentle. The author stated that the hydrostatic pressure employed should not exceed 3 feet (91.44 cm.) of water and the method should be abandoned if not successful after 3 attempts.

Fifty patients underwent operation. Simple reduction was accomplished in 30 patients, 7 of whom died, and 10 others required some other operative procedures for reduction. In 4 cases resection was required. Neither the choice of the anesthetic agent nor the type of incision had any apparent influence on the outcome in any of these cases. In this series the mortality rate was higher for white than for Negro patients, although there were considerably more of the latter. This is at variance with the higher mortality usually reported for Negro patients. The most important single factor affecting mortality was the time lag between the onset of symptoms and the patient's admission to the hospital. Only 14 of the 54 patients could be classified as good surgical risks. The duration of symptoms was longer and there were more deaths among patients who were brought into the hospital from the outside of the city than those who resided within the city. For 28 patients the average interval between admission and operation was one to four hours, and from four to nine hours for 21 other patients. Two patients were delayed nine and eighteen hours and in 2 cases in which the outcome was fatal there was a delay of four days. The author ascribes some of the fatal cases to errors in surgical judgment, and others to errors in details of care before and after operation.

An important problem is the difficult decision of whether to resect a portion of the bowel or to take a chance that this portion will return to normal state. In 3 instances nonviable bowel was found at necropsy after surgical reduction, and in another case a gangrenous portion of bowel was left in the abdomen or else thrombosis developed soon after the operation. Rupture of the bowel occurred during reduction in 3 cases. It is stated that surgical procedures were too extensive in some cases, 3 patients having submitted to appendectomy along with reduction although there was not adequate confirmation of appendicitis by the pathologist. Reference is made in 2 cases to efforts made to prevent a recurrence of intussusception. The surgical procedures proved to be unwise. Both patients suffered subsequent episodes of intestinal obstruction and neither patient survived. At least 3 patients in this series died as a result of shock. Faulty judgment in the administration of fluids accounted for 1 of the fatali-

ties. The author suggests that no operative procedure should be begun until a cannula or needle has been placed in a vein. All patients should receive oxygen continuously. The stomach should be emptied by aspiration before operation. Chemotherapy and antiobiotic therapy should be used if an infectious process supervenes. There were 4 instances of postoperative intestinal obstruction. The family of the child should be warned of this possibility so that the patient may be returned to the hospital as soon as symptoms occur. Since July, 1947, 10 infants with intussusception have been treated at this institution and there have been no deaths.

The author emphasizes that close cooperation between the surgical and pediatric staffs is required for proper management of the patients. Operations should be performed by surgeons who have a special interest in pediatric surgery and who have special experience in this field.—*C. B. Holman, M.D.*

RICHARDSON, HARRISON H. A case of ileo-ileal intussusception of unusual etiology, *Radiology*, Feb., 1951, *56*, 251–255.

Intussusception constitutes one of the more common intra-abdominal emergencies encountered in pediatrics. The entity may also be observed in adults. Organic lesions should always be considered when dealing with intussusception in the adult. Intestinal tumor, Meckel's diverticulum, hypertrophied lymphoid tissue, granulomatous, parasitic and inflammatory conditions, such as tuberculosis, amebiasis, round worm infestation, and typhoid fever have been reported as etiologic agents. Appendiceal lesions, foreign bodies, and aberrant islets of pancreatic tissue account for a small percentage of cases.

The symptoms presented are those of obstruction, either acute, chronic, or recurrent. Usually the barium enema is of no value in enteric intussusceptions unless reflux into the terminal portion of the ileum occurs. In such cases the "concentric ring" appearance is a prominent feature.

The case history of a twenty-nine year old white male with ileo-ileal intussusception due to aberrant pancreatic tissue lying beneath the intestinal mucosa is presented.—*E. M. Cooper, M.D.*

MORETON, ROBERT D., COOPER, EDWARD M., and FOEGELLE, EDWARD F. A simple one-stage method of double-contrast study of the colon. *Radiology*, Feb., 1951, *56*, 214–221.

A "Y" shaped enema tip is described for use in the roentgen examination of the colon. This tip permits the introduction of barium suspension or air without removal of the tip from the rectum. The authors describe the double-contrast examination and claim that the "Y" shaped tip facilitates the examination. Barium is first introduced under fluoroscopic control and then inflation immediately begun until the proper distribution of barium and air is obtained. Prone and supine stereoscopic roentgenograms are then made before evacuation is permitted.

The advantages of this one stage method of doing the double-contrast examination are: short time of examination, insertion of the rectal tube only once, and the ability to add more barium or air as desired. —*C. A. Stevenson, M.D.*

KNEIDEL, JOHN, H. Disseminated calcification of the pancreas: report of two cases. *Ann. Int. Med.*, March, 1951, *34*, 790–796.

The authors give a brief review of the subject and add 2 cases of disseminated pancreatic calcification complicated by diabetes and severe pancreatic insufficiency with steatorrhea.

Insulin therapy produced hypoglycemia in both of the patients because of an inability to maintain the food intake due to bouts of uncontrollable diarrhea.

The diagnosis of pancreatic calcification can usually be made directly from the plain roentgenogram, although calcified retroperitoneal lymph nodes and splenic vessel calcification may be sources of error.—*V. L. Peterson, M.D.*

PETERS, BRUNO J., LUBITZ, JOSEPH M., and LINDERT, M. C. F. Diffuse calcification of the pancreas. *Arch. Int. Med.*, March, 1951, *87*, 391–409.

Twenty-one cases of diffuse calcification of the pancreas are presented in which 6 were studied at autopsy and 1 by surgical removal of the pancreas. The diagnosis is established by the demonstration of calcifications in the pancreas by roentgen examination. The symptoms are vague and not specifically related to the pancreas. There may be pain, girdle-like, with radiation to the back or pain in either upper quadrant or mid-epigastrium. The serum amylase is important only in that it may fluctuate. Weight loss is common and diabetes was associated in 76.2 per cent of their cases.

The stones may be intraductal or parenchymal. The course in both instances is similar. Pathological findings are acute and chronic inflammatory changes, fibrosis, pseudocysts, dilatation of the ducts and the calculi.

Splanchnicectomy or pancreatic resection may be considered for relief of pain.—*Joseph Levitin, M.D.*

MILLER, EDWARD M., DOCKERTY, MALCOLM B., WOLLAEGER, ERIC E., and WAUGH, JOHN M. Carcinoma in the region of the papilla of Vater; study of cases in which resection was performed. *Surg., Gynec. & Obst.*, Feb., 1951, *92*, 172–182.

An important factor in the early diagnosis of carcinoma in the region of the papilla of Vater is the knowledge that there is a preicteric stage in this disease. Those patients with pancreatic lesions who

were studied all experienced definite and progressive weakness and loss of weight which began at least six months prior to the jaundice. A majority complained of constant epigastric pain extending to the back and intensified at night. This symptom usually arose two or three months before icterus appeared. Although a rather sudden appearance of painless jaundice was the most frequent early symptom of carcinoma of the papilla, the histories in a third of the authors' cases showed the presence of intermittent attacks of pain which began about six months prior to the jaundice. Chills and fever came in the later stages.

Roentgen examination offered positive evidence of the presence of lesions of the head of the pancreas and of the papilla in a third of the cases. It may be anticipated that roentgen evidence of the disease might occasionally establish the diagnosis during the preicteric phase.

Although four-fifths of the lesions in this series were of low grade malignancy, in almost a third of the cases the regional lymph nodes had been invaded. Of the tumors in the region of the papilla of Vater, carcinoma of the pancreas is unique in its strong tendency toward invasion of the perineural lymphatics. In the cases of pancreatic carcinoma, the larger neoplasms offered the poorest prognosis; in the lesions of the papilla, the reverse was true.

Conclusions: Radical pancreatoduodenectomy seems a rational approach to malignant disease of the papilla of Vater and of the descending portion of the duodenum. Transduodenal excision carries a high operative mortality and is inadequate as a curative operation for carcinoma of the papilla. The results of radical resection for carcinoma of the pancreatic head are discouraging although 1 patient is alive and well five years after operation.

It is often a question whether to proceed with radical resection when the lesion involves a major portion of the head of the pancreas. Frequently, however, there is doubt at the time of operation concerning the actual origin of the lesion, i.e., whether it is pancreatic or papillary. In such cases, the writers consider it advisable to perform radical resection because pathologic examination may prove that the primary lesion originates in the papilla.—*Mary Francis Vastine, M.D.*

Jackman, Raymond J., Clark, P. LeMon, III, and Smith, Newton D. Retrorectal tumors. *J.A.M.A.*, March 31, 1951, *145*, 956–962.

The authors analyze 82 patients with retrorectal tumors and find that chordomas are more common in male adults, while teratomas and meningoceles are more common in female infants. Backache, pain in the leg, bowel and bladder symptoms are most frequent. Digital and proctoscopic examinations rule out the rectum as the site for primary tumor. Roentgenographic study of the pelvis helps in locating tumors arising in the sacral canal, ependymomas or neurofibromas; those arising from the sacral body, and those arising from structures adjacent to the sacrum, such as teratomas.

The prognosis of retrorectal tumors is discussed.—*F. B. Markunas, M.D.*

Helwig, Elson B., and Hansen, James. Lymphoid polyps (benign lymphoma) and malignant lymphoma of the rectum and anus. *Surg., Gynec. & Obst.*, Feb., 1951, *92*, 233–243.

In this study it is proposed to determine the natural history and behavior of lymphomatous growths of the rectum. Many authorities conclude that all lymphoid growths are incurable but there is evidence that a favorable prognosis may be predicted if there is the combination of location in the rectum or anus and a specific histopathologic pattern. Recorded in the literature are numerous instances of lymphosarcoma, malignant lymphoma, Hodgkin's disease and allied disorders involving the anus and rectum, but death brought about by a generalized spread is rarely ascribed to these lesions. This, of course, is in distinct contrast to the recorded examples of malignant lymphomas involving lymph nodes.

Cutler states that the most common site of localized lymphosarcoma is just above the sphincter, although it may occur in the rectosigmoid or anywhere along the colon. In this study the benign lymphoid polyp occurred in the lower rectum and anus and was not noted in the rectosigmoid or in the remainder of the colon. A lymphoid lesion of the large intestine, other than in the rectum and anus, is more likely to be malignant than benign, and this is true also if lymphoid lesions are present throughout the large intestine, including the rectum. Histopathologically these lesions show the characteristic change of malignant lymphoma rather than of benign lymphoid polyp. Primary malignant lymphoma of rectum and anus is probably extremely rare, and in most instances true lymphosarcoma of this region is accompanied by similar growths elsewhere.

Conclusions

1. Benign lymphoid polyp is the most common lymphomatous growth of the rectum and anus.

2. Primary lymphosarcoma and allied malignant disorders of the rectum are rare.

3. Polypoid lymphoid growths of the rectum showing primary follicles with reaction centers are to be considered benign.

4. The structure of the lymphoid polyp suggests that the change is one of hyperplasia.

5. On the basis of the present study, the distinction between benign and malignant lymphomatous growths of the rectum should be made by pathologists without difficulty.

6. Simple excision will effect a cure of the lymphoid polyp of the rectum and anus.

7. It is suggested that the cases of primary malignant lymphoma, lymphosarcoma, and Hodgkin's disease of the rectum recorded in the literature be critically reviewed and that the claims of cure by radical surgical resection or radiation therapy be reevaluated.—*Mary Francis Vastine, M.D.*

MOSCA, LIDIO G. El enfisema retroperitoneal: su técnica, sus indicaciones y resultados. (Retroperitoneal emphysema: its technique, indications and results.) *Arch. españ. urol.*, Jan., 1951, *7*, 1–23; also *Prensa méd. argent.*, April 27, 1951, *38*, 1025–1035.

The historical development of the use of gas or air as a contrast medium in studying diseases of the abdomen is presented. In 1948, Ruiz Rivas of Spain proposed a needle puncture near the tip of the sacrum injecting air into the presacral space. This allows air to diffuse upward through the retroperitoneal areas to outline the psoas muscles, kidneys, liver, spleen, and even penetrates up through the vascular sheaths and into the neck. In taking roentgenograms about 15 to 20 kv. is detracted from the usual kilovoltage. The method has been used to outline renal tumors and cysts, hydronephrosis, perinephric abscess (lack of air around kidney), retroperitoneal tumors and cysts or tumors involving the inferior portion of the liver. In some cases the study is combined with retrograde pyelography.—*C. M. Nice, M.D.*

YOUNG, MAURICE D., and GRISWOLD, HERBERT E. Situs inversus of the abdominal viscera with levocardia; report of eight cases submitted to the Blalock-Taussig operation. *Circulation*, Feb., 1951, *3*, 202–214.

This paper is a careful report of 8 cases with autopsy findings in 2 cases. Previously 14 such cases have been reported in the literature. These 8 cases had a Blalock-Taussig operation with 3 deaths and with improvement in the other 5. In all of the reported cases, including this series, the cardiac malformations have been bizarre. No common anatomical pattern was found. Inadequate pulmonary blood flow was usual.

In view of the numerous cardiac anomalies with this condition, possible situs inversus of the abdominal viscera should be investigated in all cases of congenital heart disease.—*E. C. Baker, M.D.*

STRICKLER, JACOB H., MULLER, JOHN J., RICE, CARL O., and BARONOFSKY, IVAN D. Nonoperative treatment of retained postoperative common duct stones. *Ann. Surg.*, Feb., 1951, *133*, 174–183.

The non-operative treatment of retained postoperative common duct stones is based on two general methods of therapy. One method is to introduce substances into the common duct in an attempt to dissolve the stones. The most common solvent used for this purpose is ether. This material, however, causes pain and even shock. Other solutions that have been used alone or in combination with ether are glycerine, liquid paraffin, ethyl alcohol, chloroform, bile, and solution G.

The second method is directed at producing conditions favorable for the physiologic passage of the undissolved stone. Nitroglycerine and atropine have been used to relax the sphincters of Boyden and Oddi followed by the introduction of bile salts, magnesium sulfate and olive oil. Anesthetic agents have been injected into the common duct in order to cause analgesia of the sphincters, which is then followed by attempts to flush the stones into the duodenum. Nupercaine, procaine and metycaine are the solutions that have been used.

Neither of these two methods is entirely successful. Because of this, 4 patients with retained postoperative common duct stones were treated by a technique combining features from both methods. Nupercaine solution was introduced into the common duct and, after analgesia of the sphincters was obtained, ether or ether-alcohol flushes were used. The advantage of this technique is that it permits the sphincters to remain open. Ether can then flow over the stone and into the duodenum, carrying away any material dissolved from the stone. Good results were obtained in 3 of the 4 patients. Persistence in treatment is essential since stones in 1 of the patients did not completely disappear until fourteen weeks had elapsed.

In vitro experiments showed that ether and ether-alcohol were the only substances that proved to be highly effective in dissolving or fragmenting gallstones. Ox bile, dog bile, sodium taurocholate, solution G, 0.5 per cent acetic acid, papain and caroid all failed to have any solvent action.—*F. J. Rigos, M.D.*

ZELMAN, SAMUEL. Liver and spleen visualization by a simple roentgen contrast method. *Ann. Int. Med.*, Feb., 1951, *34*, 466–478.

Available methods of roentgen visualization of the liver and spleen are reviewed briefly. Barium has been used to outline liver and splenic enlargements. A more definite visualization of these organs has been attempted by contrast techniques. Pneumoperitoneum, accomplished by injections of amounts of air, oxygen or carbon dioxide is useful, but it may be traumatic and should be used only in selected cases. Colloidal thorium dioxide (thorotrast) intravenously is deposited in the reticuloendothelial cells of the liver and spleen and is of particular diagnostic value in abscess, cirrhosis, or tumors of the liver.

A simpler method is advocated, giving the patient one-half to one Seidlitz powder mixture in separate

one-third glassfuls of water and asked not to belch until roentgenograms are made. The drink is followed immediately by injection of air into the colon by rectal tube and bulb until the colon is filled.

Roentgenograms are made standing in the posteroanterior position for optimal liver visualization and the left oblique position for optimal spleen visualization.

The average length of the liver was 21.3 cm., measuring from the lower right edge to the highest point on the upper border, with the normal from 18 to 22 cm. The "width," measured from the highest point of the right lobe to the midpoint of the lower border, averged 12.8 cm. with normal limits of 10 to 14 cm.

Considerable variation in the normal position of the spleen was found, varying from a horizontal subdiaphragmatic position to a low lateral position between colon and chest wall.—*R. J. Reeves, M.D.*

Sante, L. R. Evaluation of aortography in abdominal diagnosis. *Radiology*, Feb., 1951, *56*, 183–192.

The technique of opacification of the abdominal aorta and its branches is described and the value of the subsequent roentgenograms in the diagnosis of abdominal conditions is discussed.

The usual contraindications for this procedure exist as for all other arterial opacification studies. The puncture of the aorta is done blindly so that the needle enters the aorta above the level of the twelfth dorsal vertebra. This prevents accidental direct injection of any of the intra-abdominal branches. Large blood pressure cuffs on both thighs prevent flow into the femoral arteries. The first roentgenogram is made at the end of the injection and another film exposed about two seconds later for study of the venous return.

Usual roentgenologic methods enable one to be quite helpful in the diagnosis of intra-abdominal conditions, but when it is necessary to determine the source, distribution and character of the blood supply of an organ or tumor, aortography is the only method available.

From a practical clinical standpoint, aortography is helpful in determining the blood supply of renal abnormalities. The test will differentiate between ptosis of the kidney and true ectopic kidney and will aid in determining possible surgical procedures in case of horseshoe kidney.

Renal neoplasm may be differentiated from cyst because of the "laking" of the blood supply in the tumor and since thin, widely divergent vessels spread over an avascular area in case of cyst. The roentgenograms will also be helpful in determining the blood supply of hydronephrotic and non-functioning kidneys. In pregnant women the placental blood sinuses are clearly visualized and the organ can therefore be exactly localized.—*C. A. Stevenson, M.D.*

Gynecology and Obstetrics

Pérez Cosío, Dionisio. Revisión de algunos métodos pelvimétricos. El método Thoms. Situación actual de la pelvicefalometría. (Review of some pelvimetric methods. The method of Thoms. Present status of pelvicephalometry.) *Cir. y cirujanos*, Oct., 1950, *18*, 461–475.

The author reviews the pelvimetric methods of Snow, Colcher and Sussman, and Thoms, all of which were used by him in a considerable number of cases. He describes in detail the positioning of the patient for the various roentgenographic projections employed with the three methods and includes several diagrams for illustration.

He then discusses the relative advantages and disadvantages of the three methods. The statement is made that the Thoms method is the most useful of the three. Its chief advantages are that it permits an excellent visualization of the pelvic inlet, it gives information as to the symmetry and asymmetry of the pelvis and makes possible the evaluation of the characteristics of the ischial spines as well as of the posterior sagittal diameters.

At the present time the author uses a combined method which is similar to that employed by Good of the Mayo Clinic. This method is an extension of the Thoms method by incorporating a determination of the subpubic arch. Three roentgenograms are made: one with the patient in a semi-seated position for the visualization of the pelvic inlet, another in a lateral view for study of the entire pelvis and the third for the evaluation of the subpubic arch.

The roentgenogram with the patient in a semi-seated position is made with the aid of the Torpin pelvimeter described in 1938 which serves to simplify the Thoms method. In view of the fact that the bi-ischial diameter suffers a lesser distortion than the diameters of the pelvic inlet, which in the average case are about 5 cm. farther away from the film, the author made a series of measurements on pelvic phantoms and determined that the distortion of the bi-ischial diameter amounts to approximately 1 cm. Therefore, he subtracts 1 cm. from the value of the bi-ischial diameter as measured on the film in calculating its actual length.

The roentgenogram in the lateral view is made with the patient lying down. The standing position has several disadvantages, the foremost of which are that it is difficult to immobilize the patient, the pubis is poorly visualized and the voltage must be considerably increased due to the fact that compression of the patient is carried out in a less efficient way.

The roentgenogram for the determination of the subpubic arch is made by following the technique of Good. The tube is angled 33 degrees toward the head

and the central ray is directed 1 cm. below the superior border of the pubis.

The measurements of the fetal head are carried out in the ordinary way. The occipitofrontal and biparietal diameters are measured on the roentgenograms taken in both the frontal and lateral views. It is recommended that prior to any pelvimetry a preliminary roentgenogram including the entire abdomen be made to determine the number of fetuses, the position and presentation, the presence or absence of gross fetal anomalies, etc.

In concluding, the author states that the Thoms method serves as a good basis for combined pelvimetry.—*T. Leucutia, M.D.*

KJELLBERG, S. R., LÖNROTH, H., RUDHE, U., and SJÖSTRAND, T. Blood volume and heart volume during pregnancy and the puerperium. *Acta med. Scandinav.*, 1950, *138*, 421–429.

In 1949 Kjellberg, Rudhe and Sjöstrand showed that in normal individuals, including men, women and children, there is a connection between the blood volume and the heart volume as determined by roentgen study. In a series of pregnant women who were examined repeatedly during pregnancy and the puerperium, an increase in the heart and blood volumes was observed before delivery and a decrease afterward. The magnitude of the change was 170 ml. in regard to heart volume and 1,500 ml. in regard to blood volume.

The variations in the heart volume were not in direct proportion to the variations in the blood volume. The conclusion has been drawn that the increase in the heart volume may depend, to a certain extent, on an increase in the heart muscle mass. However, the entire increase in volume cannot be explained on the latter basis and thus probably depends chiefly on the increase in the blood mass within the heart.—*Charles Nice, M.D.*

READ, GRANTLY DICK. Ureteric dysmenorrhoea. *Lancet*, Feb. 10, 1951, *1*, 312–315.

Three cases of intractable pain at the time of the menses are recorded as examples of one type of dysmenorrhea. In these cases there was no evidence of uterine or ovarian disease. Stricture or spasm of one ureter was diagnosed in each case, and treatment of this condition resulted in complete relief from the menstrual pain. Cystoscopy and retrograde pyelography are advised as routine procedures in the investigation of intractable dysmenorrhea. A hysterectomy or presacral sympathectomy should not be advised until the urinary tract has been examined. The psychosomatic aspects of dysmenorrhea are also discussed.—*P. R. Dirkse, M.D.*

PORTES, L., GRANJON, A., and BEAU, A. M. Ponction des kystes de l'ovaire et kystographie. (Needle puncture of cysts of ovary and cystography.) *Gynéc. et obst.*, 1950, pp. 422–431.

The authors discuss the merits of the needle puncture of cysts of the ovary with aspiration followed by injection of a radiopaque substance into the cysts. They employ a long needle and think that the best approach is via the vaginal route. They use an organic iodine compound which serves both as a contrast medium and as a sort of treatment in causing sclerosis of the cysts. However, this latter point is only in the experimental stage and new products of contrast material are being studied from the therapeutic point of view.

The authors believe that needle puncture with aspiration of cysts of the ovary, which are in the majority follicular and luteinic in nature, is in itself a valuable diagnostic procedure if the fluid aspirated is examined cystologically, chemically and biologically. The ensuing cystography gives additional information as to the position, shape and size of the cyst and perhaps is also a valuable therapeutic measure. Several fine cystograms accompany the article.—*J. N. Sarian, M.D.*

WHITE, MARGARET MOORE. False diagnosis of patency of Fallopian tubes. *Brit. M. J.*, Feb. 17, 1951, *1*, 336–338.

Gynecologists engaged in the study of infertility try different methods for the study of patency of the fallopian tubes. A false diagnosis of patency may be obtained by air insufflation and the use of the roentgen kymogram. The bubbling of air is sometimes mistaken for the passage of air through the fimbriated end. Several examples are given to substantiate the writer's belief that air salpingography is the only method of making a definite diagnosis.—*R. J. Reeves, M.D.*

GUSBERG, S. B. Coning biopsy in the detection of early cancer of the cervix; survey of 500 normal women. *Am. J. Obst. & Gynec.*, Feb., 1951, *61*, 276–288.

Improved techniques in early detection of cervical cancer are discussed, and the need for accurate diagnosis of suspected lesions is emphasized. The author considers the existing cervical scrapers and punch biopsy instruments inadequate and describes an endocervical coning biopsy curette which obtains a circumferential sample from the cervix without the necessity for hospitalization or anesthesia. The technique of biopsy is described.

The curette, along with bimanual examination and cytologic study of the cervical smear, has been used in screening examination of 500 women over thirty-five years of age without symptoms of uterine cancer. Patients with asymptomatic fibroids and cervical erosions were included, since the purpose was to

discover the detection rate in women who otherwise would have no reason to ask for gynecologic examination. In 10 of this group (2 per cent) cervical carcinomas were detected by coning biopsy. In none of these was any specific indication of cancer found on bimanual examination, although all but one showed Class IV or Class V cytologic findings. Only definite malignancies were included in this series; questionable lesions were ignored for statistical purposes.—*D. G. Ferguson, M.D.*

Tannhauser, Siegfried. Myometrium and leiomyomas in endometrial carcinoma; failure of involution and reactivation of smooth muscle tissue. *Am. J. Obst. & Gynec.*, Feb., 1951, *61*, 265–275.

Pathologic study of 58 uteri removed for endometrial carcinoma revealed a significant increase in the average size above the normal for the age groups involved. The increase in size was particularly noted in late postmenopausal uteri, and bore no relation to the size of the tumor present. Histopathologic studies are described, showing myometrial elements similar to those found in the premenopausal uterus. The author employs the term "rejuvenation" for these changes. Leiomyomas found incidentally in carcinomatous uteri frequently participated in these changes, and similar changes were noted in the few leiomyosarcomas observed. Irradiated uteri exhibited little clear-cut myometrial rejuvenation, possibly because the irradiation inactivated the previously rejuvenated myometrium.

A statistical survey is presented, showing a significant increase in premenopausal type endometrium among the malignant group, as well as an increase in average weight in the malignant series. The author concludes that the postmenopausal patient showing enlargement of the uterus or signs of reactivation in a myoma should be suspected of an endometrial malignancy or a hormone-producing ovarian tumor. —*D. G. Ferguson, M.D.*

Gilbert, René. The problem of pregnancy in Hodgkin's disease. *Acta radiol.*, Jan., 1951, *35*, 71–75.

The author states that the number of long remissions is increasing in Hodgkin's disease when treatment with roentgen rays is "properly" carried out. He feels that such treatment includes the methodical administration of a dose sufficient to destroy all granulomatous foci without damaging connective tissues, blood, or the general health of the patient. In other words, he believes Hodgkin's disease should be treated very much like malignant tumors.

He also believes that if the disease has been treated "properly" and is of the cervicothoracic type, pregnancy is not contraindicated. He has had 13 full term normal pregnancies in 9 mothers with Hodgkin's disease since 1926. In answering the question as to what should be done when there is a coexistence of pregnancy and Hodgkin's disease, he states: (1) Pregnant women who have had a mild form of Hodgkin's disease and are free from symptoms after roentgen therapy show a remarkable ability to undergo pregnancy. In these cases, the pregnancy should not be interrupted. (2) If pregnancy develops while the disease is "active" or if the disease appears for the first time during pregnancy, roentgen therapy should be tried before terminating the pregnancy. (3) The mother is advised not to nurse the child.—*Mary Francis Vastine, M.D.*

Stallworthy, John. Discussion on new ideas about the diagnosis and treatment of placenta previa. *Proc. Roy. Soc. Med.*, Feb., 1951, *44*, 121–134.

This paper considers the obstetrical problem of the diagnosis and management of placenta previa. Of interest to radiologists is the roentgen diagnosis of the condition, particularly as relates to the low posterior placenta.

The discussant's associate, Dr. F. Reid, has based his study of placentography on two main principles: (1) use of an aluminum filter to obtain clearer definition of the placenta than has previously been possible; (2) use of the effect of gravity in positioning the patient to obtain indirect evidence of the site of placental implantation.

If one accepts the belief that the lower uterine segment at term is at the pelvic brim, it follows that a low implanted placenta may pass through the os and still be beyond the reach of the examining finger. For this reason, roentgen approach is of considerable importance. A lateral roentgenogram of the pelvis taken in the erect position may show the fetal head to be displaced anteriorly in the pelvis suggesting a posterior soft tissue mass. This displacement has been seen to be caused by a posterior wall fibroid and many times by a posterior placenta. That no such cause is present can be revealed when the patient is tipped posteriorly to an angle of 60° (Reid's semi-erect position) and a second lateral roentgenogram taken. The fetal head is now seen to rest on the sacral promontory. Persistent forward displacement of the fetal head in the semi-erect position indicates a posterior placenta previa and is due to the placenta lying low over the sacral promontory.

A consecutive series of 170 patients with placenta previa showed a 20 per cent incidence of malpresentations. The placental implantation was situated posteriorly in 50 per cent, centrally in 29 per cent, and anteriorly in 21 per cent of the cases. "If central placenta previa is excluded this means that the posterior placenta was responsible for trouble in 70 per cent of the remainder." Roentgenography, therefore, is an asset in the selection of cases for expectant management. The exclusion of the possibility of ab-

normal implantation is similarly a comfort to the accoucheur.—*D. R. Bernhardt, M.D.*

TAYLOR, E. STEWART, MORFIT, MASON, and HILL, ROBERT M. The iodoacetate (Huggins) index in pregnancy. *Am. J. Obst. & Gynec.*, Feb., 1951, *61*, 362–367.

Huggins *et al.* have shown that the coagulability of the blood serum is decreased in most patients with cancer and certain other conditions, of which pregnancy is one.

The authors examined the coagulability of the sera of 173 pregnant patients, some of whom were also re-examined at the time of parturition and again six weeks postpartum, using the methods of Huggins, Miller and associates. The control group consisted of 148 healthy non-pregnant individuals. In calculating the Huggins iodoacetate index the authors used the square root of the serum protein concentration instead of the actual serum protein concentration to minimize the effect of hypoproteinemia.

The results of the investigation showed that 85.5 per cent of the pregnancy cases had indices below 9.0, the generally accepted norm, compared to 12.8 per cent of the non-pregnant group which fell below 9.0.

It is concluded that the Huggins iodoacetate index shows too many false positives (11.5 per cent) and false negatives (22.5 per cent) to be of value as a diagnostic test for pregnancy. It may, however, have some value in measuring the rate at which the metabolism of the pregnant patient returns to the pregravid state following parturition.—*H. J. Thompson, Jr., M.D.*

ACHENBACH, RACHEL R., JOHNSTONE, ROBERT E., and HERTIG, ARTHUR T. The validity of vaginal smear diagnosis in carcinoma in situ of the cervix; report of 60 cases. *Am. J. Obst. & Gynec.*, Feb., 1951, *61*, 385–392.

The authors report on 60 cases of carcinoma in situ of the cervix with the aim:

1. To determine the inherent ability of the vaginal smear to reveal the presence of such an early malignancy.
2. To assess accuracy in discovering malignant cells.
3. To consider usefulness of the technique.

A total of 11,871 vaginal smears were examined from 9,748 gynecological patients to produce the above 60 cases. A correct diagnosis was made on the initial vaginal smear in 70 per cent of the 60 cases studied. The highest diagnostic accuracy attained by the technique (obtained by reviewing the slides after positive biopsy) was 82 per cent. Vaginal smears were accurate in 54 per cent of 24 cases showing only surface malignancy, while 81 per cent of 36 cases with glandular involvement were diagnosed correctly.

A positive smear should *never* be considered as providing conclusive evidence of disease, and every effort should be made to confirm the diagnosis and locate the lesion before the patient is treated. This rule should be followed not only because of the occasional false positive result but also because in 3 of their cases the malignant area was apparently removed completely by cervical biopsy, 4 were apparently destroyed by cauterization, 2 by conization, and 1 disappeared during pregnancy.—*W. E. Conrady, M.D.*

DRUKMAN, A., and ROZIN, S. Uterovenous and uterolymphatic intravasation in hysterosalpingography. *J. Obst. & Gynec. Brit. Emp.*, Feb., 1951, *58*, 73–78.

In a series of 2,000 hysterosalpingograms 62 cases of uterovenous or uterolymphatic intravasation were observed. There were no subjective complaints or complications by the migration of the oil. In the uterolymphatic intravasation the oil could be followed to the regional lymphatic nodes and the oil was retained in some instances for years.

The largest series of venous intravasation was found associated with filling defects in the uterine cavity such as polyps and myomas. Lymphatic intravasation was found with tuberculosis of the uterus.

Other causes such as excessive pressure during the injection, direct trauma to the uterine mucosa by too long a cannula, injections performed shortly after menstruation or curettage played a minor role (18.7 per cent).—*Joseph Levitin, M.D.*

GENITOURINARY SYSTEM

SCHORR, S., WILDMANN, J., and SCHWARTZ, A. Gastric cardia shadow simulating left suprarenal tumor. *Radiol. clin.*, Jan., 1951, *20*, 55–58.

The authors briefly report 3 cases and reproduce their respective roentgenograms to illustrate the point that the gastric cardia under certain circumstances may simulate a left suprarenal tumor. This is especially apt to occur in patients with high blood pressure.

In the first patient, who had a blood pressure of 240/140 mm. Hg., following a roentgenologic diagnosis of left adrenal tumor, an operation was performed, consisting of left adrenalectomy. Soon after the surgical intervention, the patient went into shock, the blood pressure dropped to 90/60, and the patient died. The histopathologic examination revealed a normal suprarenal gland.

The second and third patients, who likewise had high blood pressure, were seen following the above-mentioned experience with the first case. In both of these patients a diagnosis of left suprarenal tumor was made roentgenologically elsewhere and they

were referred for operation. However, recalling the first case, a barium swallow was given to both patients which immediately proved that the shadow was that of the gastric cardia.

In concluding, the authors warn that when, on routine roentgen examination of the urinary tract, a massive round shadow is seen on the roentgenogram in the region of the upper pole of the left kidney the possibility of a superimposed shadow of the gastric cardia should be ruled out before a diagnosis of pheochromocytoma is made.—*T. Leucutia, M.D.*

Duffy, J. James. Imperforate anus and rectourethral fistula in a twenty-seven year old man; report of a case. *J.A.M.A.*, Feb. 24, 1951, *145*, 545–548.

This combination of anomalies which usually leads to an early death without surgical intervention because of concurrent severe urinary disturbances is presented. The author is unable to find any other such recorded case.

At birth the infant was found to have an imperforate anus. A blind stab wound in the perineum communicating with the rectal pouch was done. At the age of five a rectovesical tract was suspected. At the same time because of pica intestinal obstruction developed. A low double-barrelled sigmoidostomy was carried out. From this time until the age of twenty-seven recurrent urinary tract infections plus the colostomy habitus plagued this young man. At this time a thorough study was carried out which revealed the following: (1) communication of the posterior urethra with the descending colostomy loop; (2) colostomy; (3) absent anus (old tract could be recanalized); (4) small bladder; (5) pyuria; (6) apparent atrophy of distal colostomy loop.

Corrective surgery was carried out. At operation no more anomalies were found. The distal loop was found to be viable enough to re-establish communication with the rectal pouch. The rectourethral fistula was closed as was the colostomy.

One year following surgery the patient has no incontinence. To all intents and purposes the new anal ring has not narrowed. The bowel movements are normal.

This in summary is apparently a very unusual course of events considering the anomalies present. Even more unusual is the end result of some very competent and painstaking surgery.—*F. W. O'Brien, Jr., M.D.*

Peters, Hannah, and Young, John D. Prostatic smear in cancer diagnosis. *J.A.M.A.*, Feb. 24, 1951, *145*, 556–557.

The authors attempt to answer the question of the validity of cytological studies as an aid in the diagnosis of prostatic carcinoma. The normal prostatic secretion is described, as is the cytologic pattern seen in benign prostatic hypertrophy, inflammatory conditions and malignancy. In malignancy, as a rule, the cells are larger, usually clustered with considerable variation among individual cells. The cell borders are frequently indistinct with overlapping nuclei.

The only sure method of obtaining such a smear is by complete prostatic massage. The method of fixation is described. Staining is by the Papanicolaou method.

Of 44 malignant cases (some proved histopathologically, others clinically) 38 presented cytological evidence consistent with carcinoma, 2 were false negatives and 4 were only suspicious. Of 102 cases of benign prostatic hypertrophy, there was 1 false positive.

The answer to the initial question would seem to be in the affirmative. Their results are in general agreement with other men working independently.

The authors, however, caution the reader that in the presence of estrogenic therapy cancer cells will degenerate and where there is a favorable response the cancer cells disappear. Second, the interpretation of the completed smear requires special training before it is of significant value.—*F. W. O'Brien, Jr., M.D.*

Windholz, Frank. The roentgen appearance of the central fat tissue of the kidney: its significance in urography. *Radiology*, Feb., 1951, *56*, 202–213.

The roentgen appearance of the peripelvic renal fat tissue has been studied in 2,321 routine urograms. Visualization of this fat tissue makes possible observation of significant parts of the inner aspect of the kidney parenchyma. The parenchyma is outlined between the lateral margin of the radiolucent fat and the border of the kidney shadow.

Diffuse proliferation of the central fat tissue is seen in obesity and in diffuse atrophy of kidneys. Circumscribed proliferations are encountered in chronic pyelonephritis, kidney stones, and infarct scars. The effect of this fat proliferation on calyces and kidney pelvis is uniform and causes narrowing, separation, and elongation of calyces and narrowing of the kidney pelvis.

Atrophy of the kidney parenchyma may be recognized on urograms in which the size of the kidney shadow is not diminished. Here the radiolucency caused by the central fat tissue is enlarged, the parenchyma is narrowed, and the calyces appear empty or spastic.

Primary fat proliferation may cause deformities which are identical in appearance with deformities caused by parenchymal tumors. Differentiation is based on the radiolucency of fat and the opacity of tumors. Study of distribution of the central fat may be helpful in recognition and clarification of certain malformations of the kidneys.—*E. M. Cooper, M.D.*

NERVOUS SYSTEM

COOPER, IRVING S., CRAIG, WINCHELL McK., and KERNOHAN, JAMES W. Tumors of the spinal cord; primary extramedullary gliomas. *Surg., Gynec. & Obst.*, Feb., 1951, *92*, 183–190.

It is the purpose of this presentation to report data on 15 extramedullary gliomas along the spinal axis but without any apparent attachment thereto. These tumors have not arisen by seeding from primary intramedullary glial or intracerebral neoplasms. These neoplasms are classified into three groups: (1) intradural, extramedullary gliomas, 9 cases; (2) extraspinal gliomas, 4 cases; (3) intraspinal and extraspinal gliomas, 2 cases.

The factors brought to light by this study may be summarized as follows:

1. Lack of any apparent attachment of these tumors to the central nervous system and absence of signs of a primary neoplastic process within the brain or spinal cord.

2. The encapsulated appearance of many of these tumors.—Five of the 9 intraspinal neoplasms were described as appearing definitely encapsulated. Four of these 9 tumors were believed by the surgeon to be neurofibromas and 1 was called a meningioma.

3. Location of these tumors along the neuraxis.—The frequency with which neuropathologic conditions dependent upon congenital defects occur in the lumbosacral area has been frequently discussed. List reported that 62 per cent of the dermoid tumors in his series were present in the lumbosacral area. The mechanism of "pinching off" of heterotopias, either sensory ganglion cells, cutaneous tissue or glial nests, is considered established. The origin of dermoid tumors from cutaneous tissue "pinched off" by the neural tube cannot be doubted. The origin of gliomatous neoplasms from heterotopic glial tissue "pinched off" from the neural tube would appear to be as likely.

4. Frequent association of these tumors with congenital anomalies.—The frequency with which glial heterotopias occur in the presence of congenital anomalies has been established. Spina bifida is the most frequent congenital malformation in which such heterotopias are found.

5. Histopathology of the heterotopic gliomas.—The histopathologic characteristics of the neoplasms in this series are strikingly similar to the histopathologic characteristics of glial heterotopias. The lack of marked cellular activity, the degree of encapsulation and the cell types are almost parallel in a series of benign glial heterotopias and this series of heterotopic gliomas.

The authors believe that heterotopic gliomas develop from heterotopic glial tissue. The extramedullary gliomas reported in this study are believed to have originated from subarachnoid and subcutaneous glial heterotopias.—*Mary Frances Vastine, M.D.*

O'CONNELL, JOHN E. A. Protrusions of the lumbar intervertebral discs; clinical review based on five hundred cases treated by excision of the protrusion. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 8–30.

When the author planned the investigation, the results of which are given in this paper, he considered that the difficulties of true evaluation of treatment would be lessened if the case records were made by the individual who would subsequently examine and review them. In every case at least one preoperative examination and a number of postoperative examinations were made by the author. Further, all cases of the series were operated upon by him, except a few in which he assisted his registrar. The operative findings were immediately recorded. The records consist of 500 cases of proved intervertebral disc protrusion operated upon between January, 1938, and May, 1948, at St. Bartholomew's Hospital, London.

In this paper, the age and sex incidence are first discussed. The greatest number of cases occurred between the ages of twenty one and thirty, and thirty one and forty years. In his discussion of the pathology of the condition, he states that low back pain may be the consequence of: a tear of either the posterior common ligament or the annulus fibrosus, as in other types of sprains; stretching of the torn ligaments by the protruding nucleus pulposus, aggravated by postures and movements which increase considerable pressure within it; and possibly by the abnormal stresses developed in the muscles, ligaments and synovial (diarthrodial joints) joints of the lumbar spine in consequence of the injury to one of the large symphysial joints between the vertebral bodies. The lower limb symptoms and signs are caused by compression and stretching of the nerves of the cauda equina, or sudden injury of them, by the protruded disc. Three circumstances may obtain: (1) if a large mass of disc tissue enters and fills the spinal canal all the contained nerve roots will be compressed; (2) in the more usual type of protrusion a relatively small mass of disc tissue enters the canal and becomes intimately related to one anterior and one posterior spinal root between their point of emergence from the dural theca and their entrance into an intervertebral foramen; (3) sometimes the displacement of a large mass of disc tissue is sudden and the roots of the cauda equina suffer an acute injury and the clinical picture of a severe lesion of the lower lumbar and sacral roots is at once established.

The etiological factors in the series were injury, pregnancy and labor, physical weakness after illness or operation, and in 170 cases no etiological factor could be determined. The nature of the injury was lifting (including digging), or fall (usually on the feet or buttocks), or direct injury to the back, or twisting movements. The occupations of the patients which were recorded were heavy manual work, armed

forces, sedentary work, the latter being smallest in number, 12 per cent.

The clinical features are fully discussed with the use of tables. The clinical signs of intervertebral disc protrusion fall into three groups—spinal, tension and neurological signs. The spinal and tension signs supply information concerning the size of the protrusion and its relationship to the extradural nerve and theca. They are especially valuable in assessing the severity of the patient's pain. The neurological signs indicate the severity of the injury to the nerve fibers and assist greatly in determining which extradural nerve (and therefore which intervertebral disc) is affected. The descriptions of these three types of signs are given in great detail.

Good lumbar and sacral roentgenograms must be made in every case. They may at once reveal some other lesion such as an intraspinal neoplasm, a primary or secondary vertebral growth or tuberculous spondylitis. The spinal films may indicate the presence and level of the protrusion by showing narrowing of an intervertebral space with sclerosis of the adjacent vertebral surfaces and perhaps lipping of their margins. The films may also show congenital variations in the lumbosacral region which are important in the localization of the affected disc on the basis of neurological signs.

The author believes that sacralization of the fifth lumbar vertebra is more common than is usually stated. He described a condition called by him "occult sacralization" in which there are five lumbar vertebrae but the last is placed so high that its spine is at or just below the level of the iliac crests, the sacrum is long with perhaps five instead of four foramina, and the last rib is much longer than the true twelfth rib. Here it may well be that the apparent first lumbar vertebra is in reality the last dorsal, and the true fifth lumbar is fused with the sacrum. He believes that recognition of this abnormality has frequently explained why a protrusion of the last intervertebral disc may give rise to the clinical picture of a protrusion of the disc between the fourth and fifth lumbar vertebrae. Ten per cent of his cases showed sacralization of the fifth lumbar vertebra.

Lumbar puncture and myelography with lipiodol or oxygen, which were performed as a routine in the early days are now used only in atypical cases and, in particular, when a neoplasm is suspected. The author considers a clinical diagnosis of a lumbar intervertebral disc protrusion is more accurate than a myelographic one. The diagnosis, he claims, is readily made in most patients by a careful clinical and simple roentgenographic examination.

There were 2 postoperative deaths in the series. In regard to complications, retention of urine was infrequent. Attacks of lumbar and inguinal pain occurred in 8 cases, and in 3 patients small burns were caused in the lower limbs by the plate of the diathermy circuit. There were 3 cases in which sudden weakness of dorsiflexion of the foot occurred several years after operation. In most of the cases, a carefully performed operation designed to relieve the affected nerve fibers from forces which stretch and compress them will give satisfying relief of symptoms. In this series, 92 per cent of patients were either completely free from symptoms or very greatly improved after operation. The spinal and tension signs present before operation largely disappeared after it. The incidence of postoperative recurrence of symptoms of such severity as to indicate re-operation was 2 per cent.—*R. S. Bromer, M.D.*

Skeletal System

Tippett, G. O. Atlanto-axial fracture-dislocation. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 108–109.

A case is reported of atlanto-axial fracture-dislocation. The roentgenograms of the patient showed: (1) fractures of the anterior arch and right lateral mass of the atlas; (2) a fracture through the base of the odontoid process; (3) backward displacement of the odontoid process, the atlas and the skull in relation to the axis; (4) osteoarthritis of the mid-cervical spine.

Atlanto-axial fracture-dislocation is an uncommon injury. It is not accompanied by severe involvement of the cord or by death as frequently as is dislocation of the atlas on the axis without a fracture of the odontoid. The author regards the case reported as an example of an injury produced by hyperextension which, in persons of the age group of patient (fifty-eight years) with cervical osteoarthritis, can have even more serious consequences.

Some special signs are presented by atlanto-axial fracture-dislocation. There may be severe occipital neuragia and hyperesthesia of the back of the scalp due to involvement of the great and suboccipital nerves which are intimately related to the posterolateral arches of the atlas. There may also be dysphagia and alterations in speech and taste due to tearing and bruising of the constrictor muscles of the pharynx and injury to the corda tympani, glossopharyngeal and palatal nerves. Tippett regards it of importance to be aware of these classical signs of the injury, for roentgenograms of the occipitocervical region may be obscured by the mastoid air cells and are often difficult to interpret unless stereoscopic views or laminagrams are available.—*R. S. Bromer, M.D.*

Kessel, A. W. Lipmann. Intrathoracic meningocele, spinal deformity, and multiple neurofibromatosis. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 87–93.

Two cases of lateral meningocele and spinal deformity in von Recklinghausen's disease are reported. Of the 10 known cases of lateral meningocele, 7 have occurred in patients with neurofibromatosis.

The deformity has been variously attributed to

the action of periosteal neurofibromas or an ill-defined osteomalacia. Another opinion is that the meningocele is due to a diseased dura and not primarily to a defect in the bone. The author puts forward the hypothesis that in von Recklinghausen's disease the spinal deformity may be due to the prolonged aneurysmal action of an undisclosed meningocele or an intrathecal dilatation of the dura mater. Further study is needed to determine how commonly the spinal dura is affected in cases of multiple neurofibromatosis with deformity of the spine. At present, he can go no further than to say that a lateral intrathoracic extrapleural meningocele associated with spinal deformity in von Recklinghausen's disease constitutes a definite clinical entity the specific features of which have been evident in the case reports so regularly that it is reasonable to expect to be able to make a correct preoperative diagnosis.—*R. S. Bromer, M.D.*

PENROSE J. H. The Monteggia fracture with posterior dislocation of the radial head. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 65–73.

Two varieties of the fracture-dislocation originally described by Monteggia (1814) depend on whether the head of the radius is dislocated anteriorly or posteriorly. The anterior variety, according to Penrose, is more common and has received a prominent place in all textbooks on fractures, chiefly on account of the frequency with which the dislocation is overlooked. The posterior variety has received much less attention and there are few references to it in the literature. Most authorities put the incidence of the posterior variety at 11 to 15 per cent but in a series of 10 Monteggia fractures treated by the author, no fewer than 7 had posterior dislocations of the radial head.

The incidence of the fracture is greatest among middle-aged women. The mechanism of the injury is probably similar to that of the dislocated elbow. Penrose thinks that excessive rotation of the forearm plays no part in its production.

Internal fixation of the ulna combined with excision of the whole radial head, or its detached segment is suggested as the treatment of choice. The functional results after operation are excellent, but some slight permanent restriction of movement is to be expected. Roentgenograms of typical fractures before and after operation are reproduced.—*R. S. Bromer, M.D.*

SAVILL, DOUGLAS L. The manubrio-sternal joint in ankylosing spondylitis. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 56–64.

Pathological changes occurred in the manubriosternal joint in 72 per cent of a series of 61 cases of ankylosing arthritis. The joint can be demonstrated in roentgenograms by two projections, an oblique posteroanterior and a direct lateral. The latter gives the clearer definition, but, because of the greater lateral width than depth of the joint, a pathological process will appear less extensive than in the posteroanterior view.

In all the 21 patients over the age of thirty-five years the joint was undergoing a process of fusion that was found in only 7 of 60 healthy persons of the same age group. In the age groups twenty-five to forty-four, 35 out of 43 patients with ankylosing spondylitis showed abnormality that was noted in but 3 of 40 healthy controls. The changes in the manubriosternal joint are similar to those which occur in the sacroiliac joint. Biopsy was done in 5 cases. In 4 the roentgenograms demonstrated erosion and in 1 the joint was fused. The most notable features in the 4 cases of erosion were the areas of replacement of fibrocartilage by collagenous fibrous tissue spreading into the bone. The absence of inflammatory tissue was striking. The areas of erosion appeared to be limited by a narrow zone of sclerosis. Savill remarks that the accessibility of the manubriosternal joint makes it a convenient source of pathological material for the further study of the disease.—*R. S. Bromer, M.D.*

EGGIMANN, PIERRE. Zur Bipartition des Lunatum. (On bipartition of the lunatum.) *Radiol. clin.*, March, 1951, *20*, 65–70.

Recently the author, in making a study of the right wrist of a seven year old girl, referred with the diagnosis of "questionable hypothyroidism," discovered the presence of a bipartition of the semilunar bone.

In view of the much debated etiology of this condition, he then examined the other members of the family and found that a nine year old brother had a similar anomaly.

The roentgenograms of the right hand of the little girl revealed at the site of the semilunar two osseous nuclei of approximately the same size, one toward the volar and the other toward the dorsal aspect of the hand; the dorsal nucleus was slightly smaller than the volar. Subsequent roentgen examination of the left hand showed an identical finding.

Roentgenograms of both wrists in the case of the brother likewise exhibited two osseous nuclei, one toward the volar and the other toward the dorsal aspect of the hand, the dorsal nucleus being slightly smaller on the right and of equal size with the volar nucleus on the left.

A review of the literature reveals that Gruber classed under the name of "lunata bipartita" not only those cases in which the semilunar bone was divided into two equal parts but also all instances in which the epilunatum or the hypolunatum constituted independent parts from the semilunar bone. He considered all these anomalies as the result of double nuclei of the semilunar bone, first discovered

by Serres. Contrariwise, Pfitzner expressed the opinion that the bipartition represents only a pseudo-appearance caused by an unusually large epilunatum.

The fact that an identical anomaly was observed in two members of the same family induced the author to conclude that the lunatum bipartitum as well as the epilunatum are developmental anomalies representing variants of the same condition. Their differentiation is based on the relative size of the dorsal nucleus.—*T. Leucutia, M.D.*

Bagnall, A. W. The painful back. *Canad. M. A. J.*, Feb., 1951, *64*, 107–111.

The opinion is expressed that, in most cases, the actual discomfort of a painful back is more closely related to the patient's battle for a comfortable existence in the highspeed civilized world of today than it is to the roentgenologically demonstrated lesions so commonly blamed.

Three types of stress produce or aggravate human ailments: (a) physical stress which may vary from local trauma to sheer general "exhaustion"; (b) infective stress (1) far from the spine as in dental abscess, (2) localized to spine as in Pott's disease, (3) systemic as in malaria; (c) psychic stress which probably is the most frequent and best summed up in the connotations of the word "frustration."

The known or hypothetical mechanisms producing discomfort may be listed thus: (a) unusual muscle strain; (b) local trauma; (c) a simple lowering of the pain threshold; (d) summation of painful stimuli; (e) overactivity of sympathetic nervous system; (f) imbalance of the pituitary-adrenocortical axis.

The author emphasizes the value of a carefully taken history and a painstaking clinical examination (without clothing) and proper roentgen study including oblique films to determine whether an organic lesion of sufficient severity is present to account for the persistence and degree of pain experienced.

If nervous tension is an important factor, some physical stigma should be detected during the history taking and physical examination. These include sighing respiration; fluttering of the eyelids; halting speech; "excitable" elevation of the pulse rate or blood pressure; spastic colon; excessive sweating, flinching, flushing, or lurching during testing of spinal movements; cyanotic, cool, moist extremities; exaggeration or inhibition of tendon jerks; difficulty in relaxing muscles; obvious tremulousness, etc.

Treatment to be effective must be practical. The methods are: (a) non-narcotic anodynes and mild sedation; (b) physical therapy; (c) roentgen therapy; (d) hormones—cortisone and ACTH; (e) life adjustment—economic rehabilitation and job placement, assessing the type of work the patient can do in coordinating efforts of industry, labor unions, government and social agencies.—*R. K. Arbuckle, M.D.*

Roche, Maurice B., and Rowe, George G. The incidence of separate neural arch and coincident bone variations; a survey of 4,200 skeletons. *Anat. Rec.*, Feb., 1951, *109*, 233–252.

This is a study of the incidence of separate neural arch or spondylolysis in a survey of 4,200 skeletons and the coincidence of this defect and other congenital or acquired characters of the vertebral column. Defects of the interarticular portion of the vertebrae were found in 178, or 4.2 per cent, and affected the 4th and 5th lumbar vertebrae in 94.6 per cent of the entire group.

On the basis of race and sex, the incidence was 6.4 per cent for white male skeletons, 2.8 per cent for Negro males, 2.3 per cent for white females and 1.1 per cent for Negro females. The incidence of neural arch defects showed no marked variation within these race and sex groups for any ten year period between the ages of twenty to eighty. The anomaly occurs more frequently in Mongols than in the white or Negro races in the approximate ratio of 3:3:1.

The occurrence of an isthmal defect with other bone variations of the spine was determined. It was found that the association of this defect (1) with spina bifida occulta of the 5th lumbar vertebra and open sacrum was greater than expected normally; (2) with articulation of the transverse process of the 5th lumbar vertebra and accessory sacroiliac articulations was less than expected, and (3) with atypical number of cervical vertebrae, cervical ribs, spina bifida of vertebrae other than the 5th lumbar and spina bifida of the upper sacral segments occurred in the same proportion as would normally be expected.—*Gerald Lavner, M.D.*

Roche, Maurice B., and Rowe, George G. Anomalous centers of ossification for inferior articular processes of the lumbar vertebrae. *Anat. Rec.*, Feb., 1951, *109*, 253–259.

In the study of ossification of the neural arch of the lumbar vertebrae by dissection of 53 stillborn human fetuses and examination of 20 human embryonic and fetal specimens, a very rare anomaly was encountered. This consisted of an accessory anomalous ossification center in the region of the right inferior articular process of the second and third lumbar vertebrae. A review of the literature which included 509 fetal spines revealed only 1 previous recorded instance of this anomaly, an incidence of 0.4 per cent.

The anomaly is not important in the production of a separate neural arch because the bony bridge between the superior and inferior articular processes is complete without the accessory center. Furthermore, the accessory centers probably do not represent the small ossicles which are occasionally seen to be separated from the inferior portion of the inferior articular process in the adult, inasmuch as the former are

much larger and appear to represent the entire inferior articular process rather than an accessory portion. The unusual anomaly of a rudimentary or absent articular process seems to be due to a failure of complete development of this anomalous center.—*Gerald Lavner, M.D.*

ZANCA, PETER, and LODMELL, ELMER A. Fracture of the spinous processes: a "new" sign for the recognition of fractures of cervical and upper dorsal spinous processes. *Radiology*, March, 1951, *56*, 427–429.

Fractures of the spinous processes are usually diagnosed on the lateral view. On the anteroposterior view they are recognized only with difficulty.

The authors state that in case of fractures of cervical and upper dorsal spinous processes a diagnosis can be made from study of the preliminary roentgenograms taken in the anteroposterior view. They describe a "new" sign, consisting of a double shadow. A smooth, crescentic area of decreased density represents the fractured base of the spinous process and a denser shadow lying in the soft tissues, inferior to the base of the spinous process, represents the displaced tip.

The identification of the fracture on the preliminary anteroposterior view can serve as warning that other portions of the vertebrae may be fractured.—*E. M. Cooper, M.D.*

ROSE, THOMAS F. Disruption of the pelvis; report of a case. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 112–113.

The patient, a male aged seventeen, was speeding on a motor cycle when he hit a stationary lorry. On roentgen examination a wide separation of the symphysis pubis was found and wide dislocation of both sacroiliac joints, the right being more severely displaced. On palpation of the pubis, a separation was noted wide enough for three fingers to be sunk between the joint surfaces.

Under anesthesia it was found that both hip bones could be moved freely on the sacrum. The disruption of the symphysis could be easily accentuated or reduced by gentle manipulation. The patient was placed on his left side on an orthopedic table and the two halves of the pelvis then came and stayed together as described by Watson-Jones.

The interesting feature according to the author about this patient's injury was the severe damage to the pelvis without any bladder involvement whatever. It also illustrates the efficacy of the Watson-Jones conservative method in the treatment of such a condition.—*R. S. Bromer, M.D.*

SCANDALIS, RICHARD, GHORMLEY, RALPH K., and DOCKERTY, MALCOLM B. Arthrokatadysis (Otto pelvis). *Surgery*, Feb., 1951, *29*, 255–259.

Arthrokatadysis is defined as "an affection of the hip joint characterized anatomically by deepening of the acetabulum with mesial displacement of the inner wall." The first reference to this condition is that of Otto who in 1824 described "a pelvis with globular extensive acetabula."

The cases are divided by the authors into 2 categories: (1) those of unknown cause, and (2) those secondary to a known cause.

Two hundred thirty-six cases were collected from the literature and studied; 53 of these cases were regarded as primary and 46 were judged to be secondary in type. The authors' series comprises 50 cases, of which 41 lesions were considered primary and 9 secondary. The causative factors in the 9 cases of this series included rheumatoid arthritis, carcinoma, fractures, and septic arthritis. Of 41 cases of primary or unknown origin, 40 patients had bilateral involvement of the hips. Eighty-five per cent of the patients were female and 15 per cent were male.

Etiologic processes most frequently mentioned in the literature included osteoarthritis deformans, tabes dorsalis, localized osteomalacia, inflammation, echinococcus disease, endocrine factors, congenital defects, trauma and gonorrhea. The pelves in the group in which etiologic factors were not apparent were subdivided into four grades of intrapelvic protrusion, grade 1 being the least pronounced and grade 4 being the most pronounced protrusion. The clinical features associated with these 41 cases of primary arthrokatadysis are recorded in a table, and 5 roentgenograms illustrate the pelves in the 5 cases which are reported. Although operative procedures including osteotomy, acetabuloplasty and arthroplasty have been recommended for treatment of this condition, the authors suggest that cup arthroplasty may offer one of the preferable methods of management.—*C. B. Holman, M.D.*

FLICKINGER, F. MILES. Monostotic fibrous dysplasia of bone; report of a case involving three contiguous ribs treated by wide resection of the thoracic cage. *J. Thoracic Surg.*, March, 1951, *21*, 298–305.

This is a report of an unusual case of monostotic fibrous dysplasia with locally malignant invasive features involving the third, fourth and fifth right ribs. There was definite local destruction of the three ribs. Initially the pathologic diagnosis favored was a low grade osteogenic sarcoma. After considerable study and review by other pathologists a diagnosis of fibrous dysplasia was made. The patient has been well for three years which militates against malignancy.

The author suggests that this particular tumor may be the connecting link between benign fibrous dysplasia and those few cases which have terminated in a full blown sarcoma.

A brief review of the historic, etiologic, clinical,

pathologic and therapeutic aspects of fibrous dysplasia is given.—*T. C. Stansbury, Jr., M.D.*

Fletcher, A. G., Jr., and Horn, Robert C., Jr. Giant cell tumors of tendon sheath origin; a consideration of bone involvement and report of two cases with extensive bone destruction. *Ann. Surg.*, March, 1951, *133*, 374–385.

The authors have reported 43 giant cell tumors of tendon sheath origin from the Hospital of the University of Pennsylvania and emphasize 8 cases in which associated bone changes were demonstrated. Clinically, most of the patients were women and three-fourths of the tumors occurred on the upper extremity, usually the fingers. Local pain stiffness or disability were uncommon complaints. The typical lesion was described as being lobulated, entirely encapsulated and firm. Histopathologically, the characteristic picture was of varying numbers of so-called "*type cells*" embedded in a deeply eosinophilic collagenous stroma. These cells were frequently phagocytic in nature and contained hemosiderin deposits within their cytoplasm. Giant cells were a constant feature whereas the other elements, foam cells and cholesterol clefts, were not always present. The presence of lobulation and capsular invasion was closely correlated to the rate of local recurrence following excision.

Associated bone changes were those of erosion rather than infiltration, although in 2 instances the bony cortex had been broken through allowing the tumor to expand within the medulla. The roentgenographic picture in these instances was that of bony erosion and destruction without the expansion of the marrow cavity or thinning of the cortex one would expect in giant cell tumors of bony origin. Furthermore, the histopathological appearance of the two lesions was distinctly different. Of 17 lesions studied roentgenographically, 8 revealed secondary bone changes.

Treatment in this series consisted of simple local excision including resection of bone or amputation in 4 instances where bone involvement was significant. In 24 followed cases, the local recurrence rate was 12.5 per cent.—*J. A. Martin, M.D.*

Wright, C. J. E. Benign giant-cell synovioma; an investigation of 85 cases. *Brit. J. Surg.*, Jan., 1951, *38*, 257–271.

These tumors belong to a fairly clear-cut category, but even so, they show, gradations from the typical benign tumor to a more cellular variety of intermediate histopathological malignancy, which in turn is closely related to malignant synovioma.

The tumor must be regarded as neoplastic; it always arises from synovial membrane and should therefore be called a synovioma. These tumors are still referred to in recent literature by a variety of names, such as myeloid or giant cell tumor of tendon-sheaths, xanthomatous giant cell tumors, villonodular synovitis and xanthoma of tendon sheaths and snyovial membranes, but these terms are unsatisfactory and at variance with the true nature of the growth.

In many cases, there seems to be a definite association between injury and subsequent tumor formation (40 per cent of these cases gave a definite history of trauma at the site of the growth). Eighty-six per cent of the cases were confined to the wrist, hand and fingers, equally divided between the palmar and dorsal surfaces and 14 per cent were in the knee, ankle or foot area.

The tumor may arise from tendon sheaths, joints or bursae and, except when it involves the large joints, tends to be largely encapsulated, ovoid or rounded and usually characteristically lobulated. It is basically gray in color but may show yellow pigment due to lipoid, or brown discoloration due to hemosiderin.

In the knee joint, the tumor is almost invariably papillary and grows toward the joint cavity rather than outward as elsewhere. Rarefaction of bone may be produced by pressure, especially in the foot.

Treatment is by local excision. The tumor is not a mere encapsulated mass which can be shelled out with ease but usually has a deep synovial attachment. Hence its extirpation may not be complete and recurrences are frequent (44 of the cases in this group).

There are three common hypotheses as to their nature: (a) inflammatory; (b) result of disturbed cholesterol metabolism; (c) neoplastic. The author found no evidence of inflammation, and blood cholesterol studies, made on 17 patients, showed no indication of hypercholesterolemia. He therefore believes the tumor must be considered as neoplastic.—*R. K. Arbuckle, M.D.*

Bloise, Nora, and Amato, Pascual. A propósito de un caso de hidatidosis osea. (A case of osseous hydatidosis.) *Rev. ortop. y traumatol.*, 1951, *20*, 247–253.

This is a case report of a fifty-nine year old woman who had been treated for rheumatism five years previously. The pain persisted and two and one-half years later the patient fell and suffered a pathological fracture. She then became a complete invalid. Apparently amputation had been suggested and refused.

Roentgen examination on admission to the authors' service revealed cyst-like lesions throughout most of the left femur with almost complete disappearance of osseous structure and great alteration of the morphology of the bone. The cortex was likewise almost completely destroyed and was fragmented at numerous points. The right femur was less extensively involved but had lesions in the head, trochanter, and neck. A pathologic fracture was noted in the neck of

the left femur. Histopathologic examination confirmed the diagnosis of osseous hydatidosis.

Biologic therapy with the concentrated hydatid antigen (method of Calcagno) was tried and did relieve pain but did not noticeably modify the course of the disease.

Distant bones may also be involved probably due to hematogenous spread. The disease is malignant in one sense, namely that it grows slowly and destroys the structures involved. In the patient presented the cartilage apparently was not involved by the spread of the organism but was altered by ischemic compression and mechanical action. The spread of the lesion to the iliac bone was considered to be hematogenous in origin. The patient is residing in a convalescent home, still alive seven years after the onset of the disease.—*C. M. Nice, M.D.*

ELLIS V. H., and TAYLOR, J. G. Diaphyseal aclasis; report of an unusual case. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 100–105.

The authors report this case of diaphyseal aclasis because it presented three unusual features: (1) sudden spontaneous growth of one of the exostoses, clinically malignant but not confirmed as such histopathologically; (2) associated congenital abnormality of the cervical vertebrae; (3) roentgenographic appearance of some of the bones which might cause confusion with dyschondroplasia. The patient was a while male, aged forty, who had multiple swellings, gross enlargement of the left thigh, absence of most of the left pectoralis major muscle and marked thoracic deformity. Eighteen months before admission to the hospital, the swelling of the left thigh began to increase and become painful. The swellings elsewhere showed no increase in size. Roentgenograms showed a large tumor mass of the left upper thigh arising from the femur with dense areas of calcification scattered through it. There was also marked overgrowth of the medial tibial condyle capped by a large densely calcified chondroma. A similar condition had been present in three generations of the patient's family. It was considered that malignant change had occurred in the previously benign tumor of the left thigh. As there was no evidence of metastases, disarticulation at the hip was undertaken.

The patient died on the fourth day after operation, the cause of death being peritonitis from perforation into the lesser sac of a small acute peptic ulcer on the greater curvature of the stomach, near the cardia. The tumor of the left thigh was cartilaginous in nature. It involved the shaft of the femur and was adherent to the surrounding muscles which were partly fibrosed. It was impossible on histopathological grounds either to confirm the clinical suspicion of malignant change or to prove that the tumor was benign.

In this case, the rapid increase in size of a preexisting exostosis with pain many years after cessation of bone growth strongly suggested malignant change, and radical surgery in the authors' opinion was clearly indicated. The diagnosis of malignant change in diaphyseal aclasis must be made chiefly on clinical grounds because of the uncertainty of histopathological diagnosis of chondrosarcoma.

The patient had also fusion of the bodies and of the spinous processes of the fourth and fifth cervical vertebrae. Fusion of the vertebrae is not one of the recognized features of diaphyseal aclasis. The question arises in this case whether the fusion of the cervical vertebrae could be part of the generalized diaphyseal aclasis or whether it was a separate and coincidental congential abnormality. If bones formed strictly in cartilage or in membrane are not invariably spared in diaphyseal aclasis as is claimed by some authors, but are the site of an exostosis, then fusion of vertebral bodies might be part of the diaphyseal aclasis.

The roentgenograms of the patient showed more calcified cartilage than is usually seen in diaphyseal aclasis. This might suggest dyschondroplasia. But the masses of calcified cartilage sometimes seen in diaphyseal aclasis are not endosteal as in dyschondroplasia. In the latter, the expansion of the ends of the long bones, a significant feature of diaphyseal aclasis, is seldom seen. The case reported also had a hereditary factor which would tend to exclude dyschondroplasia which usually shows no such factor. There were also no enchondromas such as are found in dyschondroplasia.—*R. S. Bromer, M.D.*

GALLIE, W. E. First recurrence of osteomyelitis eighty years after infection. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 110–111.

This is a case report of a female patient who developed acute osteomyelitis of the right femur at the age of ten years and who had the first secondary flare at the age of ninety years. The author regards the case as not unusual except that the interval between the outbreaks was so long. He remarks that one cannot help wondering whether the staphylococci discovered at the later operation were the same that caused the original trouble or whether they were their sons or grandsons. Or, they may not have been the same family of staphylococci at all but only some wayfarers who found a place made suitable for them by their predecessors, eighty years before.

He regards the presence of a sequestrum as surprising. One would have thought that after all the years it would have dissolved or succumbed to the attacks of scavangers. There was none of the creeping replacement so characteristic of rarefying osteitis and of the rapid absorption and replacement that happens in an autogeneous bone braft, and no sign of new bone. He concludes that it is hardly worth while to wait for the absorption of a sequestrum and that it had better be removed as soon as it is loose.—*R. S. Bromer, M.D.*

Bloom, Ross, and Pattinson, J. N. Osteochondromatosis of the hip joint. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 80–84.

Three cases of osteochondromatosis of the hip joint are reported. The condition is uncommon. Roentgenograms in 2 of the cases showed defects at the cervicocapital junction and a femoral neck of rather conical shape. One case showed erosions both of the acetabulum and of the head of the femur. An arthrogram in 1 case showed that several of the osteochondromas lay in defects at the junction of the head and neck and formed a corona there. These findings suggested that the loose bodies had caused pressure-resorption of bone in this region. This hypothesis was supported by roentgenograms taken three years after operation which showed the defects to be partly filled by the deposition of new bone. The site of the erosions in the hip joint is probably determined by the characteristic distribution of the cartilaginous bodies at the synovial-cartilaginous junction. The authors believe that arthrography is of particular value in diagnosis when the loose bodies are radiotranslucent. —*R. S. Bromer, M.D.*

Oosthuizen, S. F., and Barnetson, James. Hemangioma of bone. *Radiology*, Feb., 1951, *56*, 256–259.

Hemangiomas of bone are congenital, usually involving the vertebra, skull and long bones. They are mesenchymal in origin differentiating into blood vessels. They are usually benign but occasionally true malignant angiomas may exist. The tumors are generally asymptomatic.

Roentgen findings in the vertebra consist of vertical striations, usually a convexity rather than concavity of the body, and occasionally a compression of the body.

In long bones cystic changes with well defined trabeculation may be seen closely resembling a giant cell tumor or osteitis fibrosa cystica. The occurrence of punched-out areas distal to the lower border of the tumor is suggestive of progression of the lesion. Flat and irregular bones show a reduced translucency and coarse trabeculation radiating from a common center usually at right angles to the plane of the bone.

The diagnosis is usually made by biopsy. Treatment consists of roentgentherapy unless there are definite neurological symptoms in which case surgery should be done.—*E. E. Seedorf, M.D.*

McFarland, Bryan. Pseudarthrosis of the tibia in childhood. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 36–46.

The purpose of this paper, according to the author, is to report the late results of treatment by the use of the "by-pass" graft in cases of pseudarthrosis of the tibia in childhood, to give a brief account of all the patients treated, and to discuss the possible causes of inception and maintenance of the condition. It is fourteen years since the by-pass graft was first introduced. The results in 11 cases are presented. He found that the operation was successful in securing sound bone union in 9 cases, and was unsuccessful in 2 cases. He suggests that the pseudarthrosis results from a fatigue fracture of a congenitally abnormal tibia, but its persistence depends entirely on mechanical factors. There is evidence to suggest that the underlying congenital abnormality may arise from dysplasia of the mesenchyme.

One of the failures resulted from lack of cooperation of the patient, a child of eleven months, who worked the plaster cast down the leg with a resultant crack in the plaster in the region of the popliteal space. The second failure was due to shortness of the graft which did not entirely clear the area of bone absorption. A second by-pass graft was inserted which up to the time of this report has produced and maintained union.

The operation is described in detail and various theories of the pathogenesis of the condition are discussed. The article is illustrated by roentgenograms of the cases showing original condition and end result in individual patients.—*R. S. Bromer, M.D.*

Miller, B. F. Congenital posterior bowing of the tibia with talipes calcaneo-valgus. *J. Bone & Joint Surg.*, Feb., 1951, *33-B*, 50–55.

In this paper three types of congenital bowing of the tibia are described. The first consists of anterior bowing of the middle and distal thirds of the diaphysis with the presence of an extreme and fixed talipes equinus, shortness and thinness of the lower limb as a whole, puckered depression of the skin over the salient angle of the tibial deformity and the frequent presence of other developmental anomalies. This was described by Middleton. Later, Williams pointed out that in cases of congenital pseudarthrosis of the tibia it may be intact at birth and that in these cases there is not talipes equinus and there are no associated developmental faults. This type of bowing is anterior. The two types were called by Middleton congenital pseudarthritis and congenital angulation. The author states that it is now clear that besides these two types, there is a third, less common, type in which the convexity of the bowing is posterior and medial and there is an accompanying talipes calcaneovalgus so pronounced that the foot seems to nestle in the concavity of the tibia. He believes it is a distinct entity.

Five cases of the third type are presented with illustrative roentgenograms. In all cases the calcaneovalgus deformity was fully corrected without difficulty. The posterior angulation responded well to gentle moulding and fixation in plaster at monthly intervals. The medial bowing was more resistant to correction. All 5 cases showed a moderate impair-

ment of growth in the affected leg. Miller does not know the natural course of the deformity if left uncorrected nor does he know with certainty what would be the probable outcome after fracture or after osteotomy for correction of the deformity. But the analogy to anterior bowing, with its tendency to pseudarthrosis, is sufficient to demand a cautious attitude to surgical treatment.—*R. S. Bromer, M.D.*

BLOOD AND LYMPH SYSTEM

SERVELLE and DEYSSON. Reflux of the intestinal chyle in the lymphatics of the leg. *Ann. Surg.*, Feb., 1951, *133*, 234–239.

The authors examined by means of venography and lymphography 50 patients with elephantiasis of the lower extremities or of the genital organs. Study of the lymphatics was made by injecting a contrast medium into the lymphatic vessels followed by serial roentgenograms. Diodrast and thorotrast were the materials used for injection. In the normal subject the lymph flows toward the root of the extremity. In the patient with elephantiasis the valves of the lymphatic vessels are incompetent and the lymph follows gravity. The lymphatic vessels in patients with elephantiasis measure from 1 mm. to 1 cm. in diameter.

Lymph from the leg of 5 patients with elephantiasis was found to be of the same composition as intestinal lymph. Chemical observations confirmed the idea that this lymph from the lymphatics of the leg was due to a reflux of the intestinal chyle. Because of this it is essential in the surgical technique of superficial total lymphangiectomy of the internal surface of the lower extremity to resect the ganglion of Cloquet and to close the crural canal just inside the femoral vein. This is the area through which the reflux of chyle occurs.—*F. J. Rigos, M.D.*

CARMEL, WILLARD J., MINNO, ALEXANDER M., and COOK, W. LEIGH, JR. Eosinophilic leukemia with report of a case. *Arch. Int. Med.*, Feb., 1951, *87*, 280–286.

A case report of myeloid leukemia with pronounced eosinophilic predominance is presented. Peripheral eosinophilia ranging from 33 to 79 per cent persisted throughout the course of the disease, with total white blood cell counts of 6,000 to 35,000. Almost all of the circulating eosinophils were of mature variety. There was an associated generalized lymphadenopathy, hepatosplenomegaly, advanced eosinophilic proliferation in the bone marrow, and late in the disease, leukemia cutis appeared.

The patient had three courses of treatment with nitrogen mustard, resulting in remissions of six weeks' duration after each of the first two courses. The third course was given when the patient was critically ill, and was followed by a severe leukopenic reaction. An excellent and prolonged remission of six months was obtained after urethane therapy.

This case was somewhat unusual in that the leukemia cutis appeared during a course of roentgen therapy to the spleen and right femoral lymph nodes.

The authors state that eosinophilic leukemia is a rare but distinct entity, and this case is the first reported in which leukemia cutis appeared.

The patient died fourteen months after the diagnosis was established. A complete autopsy report is given.—*G. J. Culver, M.D.*

KOPPANG, KNUT. Some examples of the diagnostic value of percutaneous carotid angiography. *Acta radiol.*, Feb.-March, 1951, *35*, 137–145.

Since Egas Moniz first introduced cerebral angiography as a new diagnostic procedure, considerable progress has been made in the field of neurodiagnosis. In fact, carotid angiography together with electroencephalography has supplemented and, to some extent, replaced pneumographic examination.

The use of cerebral angiography in neurologic practice has been greatly facilitated by the development of the percutaneous technique. Hospitalization of the patient is not a necessity when this method is employed. In 70 of the 614 cases in which carotid angiography was performed (in 1949 at Rikshospitalet, Oslo), the examination was carried out on an ambulatory basis. Surgical exposure of the carotid artery is used in this particular clinic only when separate filling of the external carotid vessels is desired.

The effectiveness of the percutaneous method is indicated by the fact that adequate filling of the intracranial vessels for diagnostic purposes was obtained in 354 of 359 angiographies performed by a single examiner during the year 1949.

A successful percutaneous introduction of the contrast medium depends to some extent on individual skill. The main requirement is experience and no one can be expected to master the method until after having performed about 200 percutaneous angiographies.

Three cases are reported in this paper to illustrate the diagnostic value of percutaneous carotid angiography. The procedure is applicable even in young children. In 1 case, that of a three year old child there was dilatation of the pupil and loss of the pupillary reflex on the homolateral side following the injection. However, these findings disappeared within a ten minute interval.—*Mary Frances Vastine, M.D.*

GENERAL

BURROWS, N. F. ELLIOTT, RENDLE-SHORT, JOHN, and HANNA, DENIS. Lead-poisoning in children; report of five cases, with special

reference to pica. *Brit. M. J.*, Feb. 17, 1951, *1*, 329–334.

Lead poisoning in infancy and childhood is considered rare in Great Britain. A survey of the literature for the past sixty years shows only 7 other reports. One infant poisoning was reported from the use of white lead as toilet powder. Two cases were due to lead nipple shields. One child chewed toy soldiers. Two children in a family developed poisoning from battery casings used as fuel. One breast-fed infant became contaminated by lead in the family water supply.

The authors report 5 cases, 4 of which exhibited pica, or perverted appetite. The clinical features, were quite the same. The emphasis is placed on encephalopathy; eye signs were also common. The lead lines and muscle palsies were rare.

The blood shows a moderate anemia, reticulocytosis and an excess of normoblasts. In severe cases there may be excessive hemolysis. The diagnosis is often first suspected from the presence of punctate basophilia in a blood film.

The urine contains a trace of albumin and glycosuria is often present.

The cerebrospinal fluid is often abnormal. In the presence of encephalopathy the pressure is almost always high.

Lead estimations in the blood and urine may give valuable confirmatory evidence.

Roentgenography is of the greatest value, as changes are practically always present. The most characteristic are the radiopaque bands, due to the deposition of lead in abnormal and condensed trabeculae at the growing ends of the long bones and the margins of the flat bones. If the deposition of lead ceases, an area of bone of normal density appears on the epiphyseal side of the band, and as the bone grows this band becomes wider and less well defined. In the presence of high intracranial tension, a roentgenogram of the skull may show separation of the suture lines.

Lead poisoning carries a grave prognosis. The younger the patient, the higher the mortality. McKhann and Vogt record that of 45 cases, 11 died and 12 had permanent sequelae.—*R. J. Reeves, M.D.*

Dundon, Sheamus. Hereditary ectodermal dysplasia of the anhidrotic type. *Irish J. M. Sc.*, Feb., 1951, *6*, 85–87.

This is a rare developmental defect presenting a symptomatic triad consisting of inability to sweat, deficiency of hair, and partial or complete absence of teeth.

About 30 cases have been described in the literature and the majority were males. It appears to be of hereditary etiology. One view considers it to be sex linked and recessive. The other view is that the transmission is mendelian and not sex linked.

Affected individuals resemble one another to a remarkable degree. The frontal bones are prominent; the bridge of the nose is flattened; the lips are thickened with radiating furrows about the mouth; the ears are satyr-like; the hair of the scalp, eyebrows and eyelashes is deficient, and there may be complete absence of teeth.

Because of the associated diminished function of the sebaceous glands these patients appear subject to eczematoid eruptions. Also, due to the diminished function of the sweat glands the body temperature of the anhidrotic patient may rise rapidly to 104° F., presenting symptoms of hyperpyrexia of unknown origin if the hereditary defect is not recognized. The author describes his case and presents photographs of the infant as well as roentgenograms that show complete absence of tooth buds and underdevelopment of the sinuses.—*W. W. Maver, M.D.*

Pack, George T., and Tabah, Edward J. Dermatofibrosarcoma protuberans; report of thirty-nine cases. *Arch. Surg.*, March, 1951, *62*, 391–411.

Experience at the Memorial Center for Cancer and Allied Diseases with a rare type of sarcoma arising within the skin is reported in some detail. The lesion is described as a firm nodular tumor usually confined to the dermis and subcutaneous tissue with stretching, discoloration and, on occasions, erosion of the overlying skin. It is relatively slow growing and extends by linear infiltration along the horizontal planes in preference to deep invasion or distant spread along vascular and lymphatic channels. This would seem to explain the tendency to local recurrence following limited excisions of the main tumor. The cut surface of the resected tumor presents a glistening grayish-white homogeneous tissue which may contain central hemorrhage and have an appearance of peripheral encapsulation due to condensation of tumor fibrous tissue. Histopathologically, it resembles a low grade, well differentiated fibrosarcoma containing large lacunar blood vessels.

Clinically, the lesion appeared most frequently in the skin of the trunk and often had been present for some years before the patient sought treatment. Bleeding and mild shooting or burning pain of short duration were infrequent complaints. The average age incidence was 44.3 years, and 61.5 per cent of the series were males. The clinical diagnosis was confused most frequently with neurogenic sarcoma and sclerosing hemangioma. The rarity of the lesion is evidenced by its incidence of 0.1 per cent of all tumor patients enrolling over a twenty-year period.

The authors recommend as the treatment of choice radical excision with a wide margin through normal tissue to include the underlying fascia even though it may not be grossly involved. In the instance of fascial involvement, the subjacent muscles should

also be removed with the specimen. Irradiation as the sole treatment is not advised. In 7 instances where irradiation was employed as a supplement to surgical excision there was little to suggest that tumor recurrence was discouraged. Metastases to regional lymph nodes did not occur in this series and the problem of management of this complication did not occur.

Of the 39 patients, 17 represented primary lesions and 22 reported with recurrent tumors after initial treatment elsewhere. Four patients out of each group experienced recurrences at various time intervals following surgical excision with or without additional irradiation. These, however, were all controlled by subsequent re-operation. Although 9 patients have been lost to subsequent follow-up, there are no known deaths resulting from the disease in this series. Two patients died of other causes.—*J. A. Martin, M.D.*

RIVEROS, MANUEL, and PACK, GEORGE T. The glomus tumor; report of twenty cases. *Ann. Surg.*, March, 1951, *133*, 394–400.

The normal glomus is a cutaneous structure consisting of an arteriovenous fistula without an intermediate capillary bed and with the function of regulating blood flow to a part. The glomus tumor is a rare benign neoplasm of the skin and subcutaneous tissues arising from the glomic end-organ, usually on the extremities. Histopathologically, it exhibits considerable variation in structure but resembles the normal glomus and contains the characteristic polygonal epithelioid cells which are usually supplied with non-myelinated nerve fibers. In some instances, the contained blood vessels are so large that the tumor may resemble a true angioma. Grossly, the lesion is usually small, varying in this series from 5 mm. to 2 cm. in diameter. If superficially placed, it presents variations in color from deep red to purple or blue and exhibits striking changes in color with temperature changes. The most common location is in the fingers, and most of these are subungual where they are associated with clear cut erosion of the cortex of the terminal phalanx as visualized on the roentgenogram. Exquisite pain occurring spontaneously or after pressure, trauma or temperature change is characteristic and may be associated with sympathetic vasomotor disturbances such as localized sweating or Horner's syndrome. Simple surgical excision is sufficient treatment and provides prompt and complete relief.—*J. A. Martin, M.D.*

RADIATION THERAPY

DEFEO, EDWARD, REITMAN, PAUL H., and NATHAN, M. HERBERT. Radiation sickness and its treatment with dramamine. *Radiology*, March, 1951, *56*, 420–422.

Radiation sickness may manifest itself mildly or exhibit such severity as to interfere seriously with the proper administration of essential therapy. In the experience of the authors, reactions of this nature have not proved an obstacle to therapeutic irradiation.

In a specific survey of 668 consecutive patients, 100 cases of radiation sickness were observed, an incidence of 15 per cent. In only 46 of these 100 patients was any improvement noted following dramamine. One-half of this number had no recurrence after administration of the drug for one day (400 mg.). In the remainder, it was necessary to give the drug daily throughout the treatment. In the latter group, symptoms recurred about two days after the drug was discontinued.

Of the 46 patients claiming improvement with dramamine, 24 were given placebos identical in appearance to the drug. Seventeen of the 24 patients (70 per cent) did as well with the placebo as with the drug itself. These results emphasize the important role of psychogenic factors in radiation sickness.

The authors believe that the effectiveness of dramamine in radiation sickness is proportional to its antihistamine effect, and it is generally known to be one of the less effective antihistamines. The problem of radiation sickness will not be solved until there is more general agreement as to its cause.—*E. M. Cooper, M.D.*

MATTICK, WALTER L., and MEEHAN, DONALD J. Carcinoma of the gum. *Surgery*, Feb., 1951, *29*, 249–254.

Carcinoma of the gum was found to comprise 1 per cent of all malignancies seen by the authors over the period of 1937 to 1944. One hundred and one cases of squamous cell carcinoma of the gum were treated by irradiation alone over this period. In review of the cases syphilis was not found to be an etiologic factor but poor oral hygiene was found in a majority of the cases. The lesions were uniformly distributed, except in the midline, where occurrence was uncommon. Symptoms usually were slight and the complaint usually was a sore on the gum. Many lesions looked innocuous and the importance of biopsy was verified.

In treatment of these lesions all modalities of irradiation were used. Usually gamma radiation to 6,000 gamma roentgens on the surface of the lesion was combined with external roentgen therapy, but in appropriate cases intraoral roentgen therapy was also used. Treatment to metastatic lymph nodes was given either in the primary portal or with separate portals. Radiation osteomyelitis occurred in 16 per cent of the cured cases.

A five year survival of 19 per cent was obtained for the entire group. By excluding patients with bone and lymph node involvement, the five year survival was 36 per cent. Because of this difference in prognosis roentgenographic examination of the

underlying bone structures and careful palpation of the neck for metastases is essential. In this group 52 per cent developed metastatic lymph nodes during the course of the disease and 47 per cent showed invasion of neighboring bone.

No survivals occurred in the group having either bone or lymph node metastases. Considering this, the authors point out the advisability of treatment combining both surgery and irradiation.—*R. W. Emerick, M.D.*

Henry, J. A., and Johner, W. La radiothérapie rotatoire des neoplasmes oesophagiens. (Rotation therapy in esophageal neoplasms.) *J. belge de radiol.*, Dec., 1949, *32*, 276–288.

The results of radiation therapy in esophageal neoplasms have been generally poor. Recent advances in roentgen therapy indicate that better results may be anticipated with supervoltage and particularly roentgen rotation therapy or "cyclotherapy."

Roentgen rotation therapy would seem to be the method of choice for treatment of esophageal neoplasms. Theoretical considerations are fully developed by the authors. Within the limits of usual deep roentgen therapy, the quality of radiation and focal-skin distance are no longer factors of great importance. From the standpoint of integral dose rotation roentgen therapy can be utilized without alteration of the patient's general condition. Tumor doses of the order of 5,000–6,000 r can be delivered safely in thirty days.

Symptoms disappear in 90 per cent of the cases, but temporarily only. In carcinoma of the esophagus, Nielsen has reported 25 per cent survivals of one year or more by using rotation roentgen therapy. Perforation of the esophagus is a danger.

The authors describe in detail the apparatus utilized in their tumor clinic. They use intra-esophageal ionization chambers for direct determination of depth doses at the level of the treated lesion of the esophagus. In their estimation rotation roentgen therapy or "cyclotherapy" represents a definite hope to improve the results from treatment of cancer of the esophagus.—*Jean Bouchard, M.D.*

Köhler, Rolf. Roentgen treatment of cancer of the oesophagus. *Acta radiol.*, Feb.-March, 1951, *35*, 207–220.

The treatment of cancer of the esophagus gives extremely poor results as compared with other carcinomas. This is due to several factors: (1) the early symptoms are rather vague and neither the patient nor the physician is impressed by them so that valuable time is often lost; (2) the esophagus is a canal with thin walls from which metastases occur at an early stage; (3) owing to its position both surgical and radiological treatment are involved and the surrounding vital organs are easily injured.

With the development of thoracic surgery, radical operation of carcinoma of the esophagus has been more and more employed. It is a method of value but as very few of the diagnosed cases are operable, other forms of treatment have to be found.

The majority of the malignant neoplasms in the esophagus are squamous cell carcinomas and fairly radiosensitive. They are usually not well differentiated and are highly malignant. Heavy doses of radiation are required if any benefit from this type of therapy is to be obtained.

Technique and Dosage. In almost all the cases treatment was given with 190 kv., 12 ma., 60 cm. focus-skin distance, 1 mm. Cu. filtration. The treatment fields varied, consisting, as a rule of two vertical anterior fields and two posterior fields with horizontal fields above or below them (usually 8 by 10 cm. in size).

The site of the tumor was determined by means of fluoroscopy. Each field was given 3,000 to 3,500 r, one field being irradiated each day, the skin dose varying between 300 and 600 r. The main object in treatment was to give the patient a tumor dose of at least 5,000 r through fractionated radiation with about 150 r per day. This was done in 45 per cent of the 296 cases. The maximum was fixed as 6,000 r, and this dose was given to all patients who could tolerate it; 5,000 r is considered the minimum dose in treatment of squamous skin cancer and less should not be given in carcinoma of the esophagus.

Summing up his results, the author states that roentgen treatment of patients with cancer of the esophagus has a certain life-prolonging effect but not for longer than a four to six month average. Of the 296 patients in this series, 2 patients were alive five years and one month and five years and three months respectively after treatment; these 2 cases are described in detail.

It is noted that a satisfying palliative effect is not achieved until a depth dose of about 3,000 r has been given. Treatment is not recommended in cases with high sedimentation rates or in those in poor general health.—*Mary Frances Vastine, M.D.*

Lahey, Frank H., and Hare, Hugh F. Malignancy in adenomas of the thyroid. *J.A.M.A.*, March 10, 1951, *145*, 689–695.

There is wide variance in the reported incidence of malignancy in thyroid adenomas. Among the causes for this is the difficulty of separating discrete adenomas from nodular goiter in areas where endemic goiter is present. At the Lahey Clinic, in 1,971 patients having a single thyroid nodule the incidence of malignancy was 10.04, whereas in 1,782 patients with multiple nodules, the incidence of malignancy was 0.62 per cent.

The discrete adenoma is to be considered a true tumor, with a true capsule, proneness to be single and variability of differentiation. The multiple adenomatous goiter is not a true tumor, containing

multiple masses without true capsules, and being well differentiated. Most malignant thyroid tumors in this series had existed for several years before operation, in spite of the accessibility of the thyroid to palpation.

The authors believe that all discrete adenomas should be removed at any age. Their preference is for local excision, taking care not to rupture the capsule, though they will not quarrel with those who advocate lobectomy. Further therapy depends on the microscopic report. Radical dissection of the cervical lymph nodes is done when there has been erosion into the lymphatics or blood vessels within the adenomas, or erosion through the capsule, and in all cases of alveolar adenocarcinoma, small cell carcinoma and giant cell carcinoma. Radical neck dissection is not indicated for papillary adenocarcinoma unless, as in the discrete adenoma, there has been erosion of the capsule or invasion of the lymph or blood vessels within the tumor.

Papillary cystadenomas and alveolar adenomas require no postoperative irradiation unless there has been extension into surrounding tissue or lymph nodes. The authors imply that in all other cases postoperative irradiation is indicated. The aim is to deliver a total tumor dose of 4,800 r in twenty-eight days by employing roentgen rays of a half-value layer of 2 mm. of copper or more. The treatment area includes the tumor bed and regional lymph nodes. The high rate of recurrence in alveolar adenocarcinoma signifies that in this type a higher dose is desirable whenever possible.

When both lobes of the thyroid are involved, the chance for cure is so slight that the risk of damaging both recurrent laryngeal nerves by total thyroidectomy is not justified. In such cases unilateral subtotal thyroidectomy and tracheotomy are done and roentgen therapy given. The prophylactic tracheotomy diminishes the risk of emergency tracheotomy which might be required after irradiation in cases where the trachea is encircled by malignant tissue.—*H. J. Klos, M.D.*

HERRMANN, JULIAN B. The effect of hormonal imbalance on advanced carcinoma of the male breast. *Ann. Surg.*, Feb., 1951, *133*, 191–199.

Operable carcinoma of the male breast should be treated by radical or simple mastectomy, depending upon the patient's physical condition. Simultaneous orchiectomy and mastectomy or the initiation of estrogenic therapy in the immediate postmastectomy period should not be done. It has been postulated that the relatively short duration of improvement observed in some patients with advanced breast cancer following the production of hormonal imbalance, is the result of a delayed compensatory adrenal activity which counteracts the produced imbalance. If this is valid, then the prophylactic production of hormonal imbalance could deprive some patients of a chance for palliation by this procedure when metastases do occur. Until more evidence is available, it would seem that the production of hormonal imbalance should be reserved for such time as symptomatic metastases or the likelihood of pathologic fracture appears.

When widespread metastases occur, orchiectomy is the procedure of choice. In some patients estrogenic therapy has caused metastases to disappear. Primary breast cancer, however, has appeared in several patients with advanced prostatic cancer treated with estrogens. This possibility, along with the inability of some men to tolerate even small doses of estrogen and the occasional production of toxic hypercalcemia by the hormone, may limit its usefulness in the treatment of male breast cancer.

Pituitary irradiation in order to depress adrenal function and in this way influence metastatic breast cancer is worthy of further investigation.

The author reports 6 patients with widespread metastatic carcinoma of the male breast treated by the production of hormonal imbalance. Orchiectomy effected palliation for variable lengths of time in these patients. The results are unpredictable inasmuch as lesions of apparently the same type reacted differently to castration. Osseous and pulmonary metastases responded better than hepatic metastases.—*F. J. Rigos, M.D.*

SEYSS, RÜDIGER. Röntgenkleinstdosentherapie bei unspezifischen Entzündungen der Lunge. (Roentgen therapy with minimum doses in nonspecific inflammations of the lung.) *Radiol. clin.*, March, 1951, *20*, 111–119.

After a brief review of the literature on the value of roentgen therapy in pneumonias, the author describes his own technique, the essential feature of which is that very small doses are used.

The factors are as follows: 180 kv., 0.5 mm. Cu plus 1 mm. Al, 4 ma. and 20 r/min. A dose of only 1 to 5 r is given. First the fields were 10 by 15 cm., then 20 by 20 cm. in size and at the present time the entire thorax as well as the head is exposed at 80 cm. skin target distance. In acute cases the treatment is applied daily; in the chronic cases two or three times a week. The head is included to obtain an effect on the neurovegetative center in the hypothalamus.

During the past two years 72 cases were treated in all. Of these, 8 had a disease process lasting less than two weeks (acute pneumonia), 53 more than two weeks, 8 had chronic bronchiectasis and 3 were unclassified.

The author does not wish to place too much emphasis on the results obtained in the acute cases since the number is too small and pneumonias may heal spontaneously or as a result of chemotherapy. In the 53 patients with the duration of more than fourteen days, in whom residual infiltrations follow-

ing pneumonia were present, the results obtained were very definite. In 22 of these a complete resolution was obtained following an average of six exposures; 23 showed slight sequelae such as adhesions and increase of the hilar markings, and in only 8 did any evidence of more pronounced pleural thickening remain. A clearing up of the residual infiltration was obtained in an average of twenty-one days. It is the author's impression that favorable results were obtained also in the 8 patients with bronchiectasis.

Three specially classified cases included infection following a perforated diverticulum, breaking down of pneumonia with cavity formation and a questionable tumor, which all responded well to the irradiation. It is stated in conjunction with this latter case that the roentgen irradiation may act as a therapeutic test in permitting a differentiation between an inflammatory focus simulating tumor and a true tumor.

In concluding, the author expresses the opinion that roentgen therapy with the above described technique is of definite value despite the present use of chemotherapy in inflammatory conditions of the lung. The extremely small doses have proved particularly useful in clearing up residual processes. —*T. Leucutia, M.D.*

Pape, Rudolf, Pendl, Oskar, and Seyss, Rüdiger. Prophylaktische Röntgenbestrahlungen bei artefiziellen pneumonischen Infekten. (Prophylactic roentgen irradiation in artificially produced pneumonic infection.) *Strahlentherapie*, 1951, *84*, 449–458.

Glauner, in his excellent book dealing with roentgen irradiation of inflammations (Die Entzündungsbestrahlung, Leipzig, 1940) considers the use of roentgen therapy in acute lobar pneumonia as dangerous and therefore contraindicated. In bronchopneumonia the outcome is more favorable but the best results are obtained in the chronic pneumonias with delayed resolution.

The roentgen dose commonly used for the treatment of inflammations varies between 50 and 200 r. Very recently, however, several reports appeared in the literature (Palugyay, Seyss, Fetzer) claiming good results from much smaller doses, ranging from 1 to 20 r, which are called microdoses.

The authors undertook a series of experiments to test the efficacy of very small doses of roentgen rays in the prevention and healing of artificially produced pneumonias in guinea pigs. The experiments were conducted along identical lines with those of Fried. Lethal cultures of *Staphylococcus hemolyticus aureus* were injected through an incision on the neck intratracheally. The animals, as a rule, became very ill on the second day and died on the fourth day. Roentgenograms revealed complete opacity of the entire right lung and the histopathologic study showed dense inflammatory infiltration of practically all alveoli of the right lung.

The 44 animals employed for the experiments were divided into four lots; 6 animals were used for the determination of the lethal dose of the staphylococcus; 10 were used for control; 6 were irradiated prophylactically before the injection; and 20 were irradiated therapeutically after the injection of the pneumonia bacillus. The factors of the roentgen irradiation were as follows: 180 kv., 0.5 mm. Cu, 4 ma., and 160 cm. distance, or 120 kv., Thoraeus filter and 125 cm. distance. The entire body of the animal was exposed so that the diencephalic centers, which according to Sturm pay such an important role in pneumopathies, were included in the field of the irradiation.

The results obtained are analyzed in detail and tabulated.

It was found that none of the 22 effectively irradiated animals developed any macroscopically demonstrable pulmonary changes. Four animals were irradiated ineffectively and 3 of these died. Of the 10 animals of the control lot, 8 died and the other 2 developed a milder pneumonia. The effective irradiation according to the authors consisted in the administration of 1–5 r at an interval of not more than one or two days from the time of the infection. This dose was repeated several times. Longer intervals, doses of 150 r (or more) as well as single exposures with 1/10 r proved ineffective.—*T. Leucutia, M.D.*

Côrte-Real, Manoel. Radioterapia hipofisária. (Radiation therapy of the hypophysis.) *Cadernos Científicos*, Oct., 1950, *2*, 401–424.

Unlike other methods of treatment, radiation therapy of pituitary lesions was not preceded by experimental investigations. Béclère approached the problem clinically in 1918 by stressing the particular suitability of the sella turcica for irradiation with multiple fields in view of its central location within the skull. He reported numerous favorable results, which, however, on later analysis proved too optimistic.

The first pituitary experiments were performed by Brunner, Strauss and Geller, independently, in 1920. These investigators irradiated the normal pituitary gland of dogs, guinea pigs and rabbits. Their published findings provoked considerable discussion resulting in a sizable literature of a rather controversial nature.

The recent contributions are more in agreement with one another. It may be accepted now as definitely proved that there is a difference in the radiosensitivity of the constituent cells of the pituitary gland, the chromophil cells showing pronounced radiosensitivity and the chromophobe cells being less sensitive. The author attributes this to the fact that the chromophil cells, which are rich in granules, exert great functional activity, whereas the

agranular chromophobe cells are practically devoid of function. The secondary effects of the irradiation of the pituitary gland are more marked in young than in adult animals. They manifest themselves mainly as disturbance of growth and atrophy of the genital apparatus and to a lesser degree as atrophy of the thymus and hypertrophy of the thyroid gland and adrenals. Very recently, Keller demonstrated that irradiation of the entire skull with doses which produce no histologic changes of the pituitary gland leads to increase in the percentage of thyroid and gonadotrophic hormones. The posterior lobe of the pituitary is resistant to even large doses of radiation.

In discussing the radiation therapy of various lesions of the pituitary gland the author states that the rationale of such therapy is based on the fact that "endocrine glands possess a much greater radiosensitivity when affected by a morbid alteration than when being in a normal state." He divides the lesions of the pituitary gland amenable to irradiation into (A) non-neoplastic, and (B) neoplastic, and establishes the following therapeutic indications:

(A) Non-neoplastic lesions: (1) pituitary cachexia-stimulative irradiation is sometimes used with questionable results; (2) gigantism—irradiation is recommended only in the brisk forms with splenomegaly and enlargement of the heart, liver, thyroid gland or thymus; (3) pituitary dwarfism and adiposogenital dystrophy—stimulative irradiation and, in case of hydrocephalus, irradiation of the carotid plexus are employed, with questionable results; (4) menopausal symptoms—irradiation is very beneficial in artificial as well as physiologic menopause associated with severe symptoms; (5) amenorrhea and dysmenorrhea—Werner reports 75 per cent favorable results in amenorrhea; (6) diabetes insipidus—the results are questionable and the mechanism of action is difficult to explain; (7) Graves' disease at menopausal age—pituitary irradiation is associated with radiation therapy of the thyroid gland or given after its failure; (8) diabetes—improvement may be obtained in insulin-fast cases; (9) bronchial asthma—irradiation of the pituitary and adrenal glands at times produces amelioration on the same basis as injections of pituitrin and adrenalin; (10) arterial hypertension—irradiation is of value in the cases of endocrine etiology although a possible action on the carotid sympathetic plexus must also be taken into consideration; (11) arteritis—in certain forms of arteritis, characterized by an endocrine-vascular-sympathetic syndrome, irradiation of the pituitary gland and of the neurovegetative centers may prove useful but this procedure necessitates further study.

(B) Neoplastic lesions. This group includes the conventional pituitary and parapituitary tumors. Radiation therapy in these is discussed in detail, several typical case reports being used for documentation. The best results were obtained in the chromophil adenomas, followed by the chromophobe adenomas. In the basophil adenomas an association with irradiation of the adrenals is recommended. Contraindications are: (a) cases with rapidly progressive loss of vision; (b) craniopharyngiomas, although palliative irradiation in the inoperable cases may be attempted, and (c) those cases in which a sudden aggravation occurs during the course of irradiation already undertaken when further treatment must be interrupted.—*T. Leucutia, M.D.*

MURPHY, WALTER T., and SCHWIPPERT, HARRY. Pituitary irradiation in prostatic carcinoma. *Radiology*, March, 1951, *56*, 376–383.

Pituitary irradiation as an adjunct to orchidectomy and stilbestrol in the treatment of prostatic carcinoma is discussed. Thirty patients received varying total depth doses with favorable responses in all. The optimum dosage technique and the relationship to orchidectomy and stilbestrol has been determined. A discussion of the endocrine pattern and the effects of irradiation upon the pituitary gland are presented. —*E. E. Seedorf, M.D.*

LEDDY, EUGENE T., and MARSHALL, THOMAS M. Roentgen therapy of pituitary adamantinomas (craniopharyngiomas). *Radiology*, March, 1951, *56*, 384–393.

The authors present a report based on 10 cases of pituitary adamantinoma in which remission or improvement of symptoms could be attributed to roentgen therapy.

The intervals and dosages of irradiation varied widely. Patients who received postoperative irradiation showed more improvement than those treated by surgical measures alone.

Microscopic examination did not reveal any effect of irradiation on the tumor in cases in which this type of treatment obviously produced clinical improvement. Roentgen irradiation probably inhibits the formation of cystic fluid by destroying the secretory power of the tumor cells.—*E. E. Seedorf, M.D.*